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EDITORIAL

NOW in its 52nd year of publication Skinner's "Oil and Petroleum Year Book" for 1961 made its appearance early this month.[1] This year the book contains complete particulars of 1,100 companies engaged in the oil business in all parts of the world and, as usual, carries sections serving as guides to equipment buying and to professional services available to the industry.

"MECHANIZATION of Mines in India" is the title of a symposium to be held from December 9 to 12 next at the Central Mining Research Station, Dhanbad. An exhibition of mining machinery and equipment is to be held in conjunction and will remain open until December 22. The papers to be presented cover: (1) Winning, methods of work and detailed operations; (2) transport; (3) ventilation and blasting; (4) supports and roof control, and (5) safety.

APPLICATIONS are invited by the Institution of Mining and Metallurgy for grants from the Bosworth Smith Trust Fund for the assistance of postgraduate research in metal mining, non-ferrous extraction metallurgy, or mineral dressing. Grants will be considered towards working expenses, the purchase of apparatus, and the cost of visits to mines and plants in connexion with such research. Applicants should send full details of their qualifications and proposals to the Secretary, not later than November 30 next.

THE president-elect of the Institution of Mining and Metallurgy for the session 1962–63 is Mr. J. B. Simpson, mining consultant to Anglo-French Exploration Co., Ltd. After leaving school and service in the R.A.F. in 1918–19 he was trained at the Camborne School of Mines from 1919 to 1922. Until 1928 Mr. Simpson was engaged in tin mining in Cornwall, Northern Nigeria, and Bolivia, after which he spent nine years at the Champion Reefs mine on the Kolar Gold Field, South India, and one tour on the Gold Coast at Konongo Gold Mines in 1938–39. During the war years Mr. Simpson served in the Royal Engineers, first with the 170 Tunnelling Coy. in France and then commanding the 173 Tunnelling Coy., which he took to Malta in 1941. At the end of 1942 he succeeded the late Col. L. C. Hill as C.R.E. in command of the 1st Tunnelling Group R.E. until 1945. After the war he joined New Consolidated Gold Fields as assistant engineer in the London office and remained there for ten years, ultimately succeeding Mr. A. R. O. Williams as Resident Engineer. During this time he made periodic visits to India, Colombia, and Burma. Mr. Simpson joined the Institution in 1921 and was elected an Associate Member in 1927 and a Member in 1944. He served on the Council from 1951 to 1958 and has held office as a vice-president since 1959. He has served on the management committee of the Benevolent Fund for the last eleven years and as chairman since 1956. He is a governor of the Camborne School of Metalliferous Mining.

Diamond Research in South Africa

The principal functions of the Diamond Research Laboratory, founded in Johannesburg in 1947, are to improve the existing applications of the diamond in industry and expand its usage and, in addition, to carry out fundamental work into the structure and properties of the diamond. The Laboratory, the only one of its kind in the world, has recently taken steps to direct public attention to its activities and to this end has published a neat pamphlet entitled "The Diamond Research Laboratory" for free distribution.[1] This publication has been prepared to describe the fundamental and applied research into the diamond undertaken by the Research Laboratory in South Africa and to acquaint users of industrial diamonds with the service the Laboratory provides.

After an introductory note outlining the objectives of the Laboratory, the research work is described under the various sections into which it is divided—physical, chemical, metallurgical, and those devoted to

[1] London: Walter E. Skinner. Price 40s.; postage, 3s.

[1] London: The Industrial Diamond Information Bureau, 2, Charterhouse Street, E.C. 1.

grinding and drilling. The physics section, for example, is concerned mainly with fundamental research. During investigations it has been found that one particular type of diamond—the Premier natural blue—is a semi-conductor capable of rectifying alternating current. Such diamonds may, therefore, be used as transistors, it is suggested, and have the advantage that their efficiency is not reduced by large fluctuations in temperature. Certain diamonds have also been found to act as counters of radioactive emanations; these could be used to detect radioactivity where other methods are difficult to apply—in the human body, for example, or in deep boreholes. The physics section has also developed equipment which enables the diamond to be correctly oriented in tool tips to take advantage of the direction of greatest hardness. In the chemical section diamond users can be advised on the recovery of used diamond from industrial wastes and other work includes investigations into the methods of improving natural industrial diamond grit and on the development of a specially hard matrix for diamond-drill crowns. In the drilling section itself investigations are continuously undertaken to improve the diamond crowns used for drilling oil wells and in the preparation for rock blasting. Testing is carried out under controlled conditions simulating those found in practice and variables such as pressure on the bit, power consumption, rate of penetration, etc., in drilling various materials are measured. It has also been found possible to increase the efficiency of drilling crowns by as much as 80% by rounding and polishing the diamonds by special processes. Field tests have shown that diamonds processed in this way drill approximately 80% further than untreated stones.

To our readers, perhaps, it will be the work of the metallurgical section which is of the greatest interest. This department concentrates mainly on improving methods of extracting diamonds from the rock in which they are found. Three methods of separation developed, all of which have been described in the literature, can be noted here. The first is the electrostatic separator, while the second method is the grease belt. In the third method, the optical separator, an intense beam of light is thrown on to the diamond-containing material and reflected by any diamonds present. A sensitive photo-electric cell, forming part of an electronic circuit, which triggers a divider gate, picks up the reflected beam so that the diamonds are directed into a different channel from the waste material. In addition to this work various improvements have been effected in the methods of concentration. Finally, in the geological section samples sent in by prospectors are examined to determine whether the material is diamondiferous.

Australian Lead

Towards the end of August it was announced in Melbourne by Broken Hill Associated Smelters Pty., Ltd., that an agreement had been concluded for the sale of 45,000 short tons of surplus Australian stocks of lead metal to the Commodity Credit Corporation, an agency of the United States Government. This, it was stated, will have the effect of clearing substantially the surplus lead metal stocks held in Australia as a result of voluntary marketing restrictions operating under United Nations agreements. Delivery over a period not exceeding 12 months is provided for and the agreed price is to be related to the current world price for lead and represents about £A3,600,000 from the sale. The statement by Associated Smelters said that the sale represents part of a programme announced by the U.S. Government representatives at the International Lead and Zinc Study Group meeting held in Mexico City last April to discuss barter of surplus agricultural commodities for surplus lead under certain conditions. One condition of the sale is that Associated Smelters and the Broken Hill mining companies undertake not to sell or produce during the present calendar year in excess of figures provisionally agreed on at the Mexico City meeting. This will limit production and sales of refined lead to 162,417 long tons a year, whereas refining capacity at Broken Hill is at least 200,000 tons a year.

The surplus lead stocks to be bartered by the Broken Hill group have accumulated as a result of restrictions the group has imposed on itself at previous meetings of the Lead and Zinc Study Group. The Australian News and Information Bureau recalls that a number of major producers agreed at Mexico City to reduce output in 1961 because of the depressed state of the lead market and the further accumulation of stocks, particularly in the United States, but it is thought that the announcement by the last-named country—that it will open its barter stockpile for lead—points to a significant reduction in stocks.

The decision to barter stocks applies only to those accumulated before the end of 1960 and affects only the producers who had accumulated stocks as a result of self-imposed restrictions since the middle of 1959.

Australia is the leading world producer of lead, but production has fallen each year since 1957 due directly to unfavourable marketing conditions. Broken Hill Associated Smelters operates what is thought to be the largest lead refinery in the world at Port Pirie, but in far western Queensland Mt. Isa Mines, Ltd., has developed production from its lead-zinc body and for the year 1960–61 increased lead bullion production by 2,780 tons to 53,000 tons. That company, it will be recalled, operates lead-smelting facilities on the field but does no refining. The total lead bullion production is exported to the United Kingdom for refining.

Asbestos

" Asbestos the Raw Material " is the title of a recent booklet put out by the Cape Asbestos Fibres, Ltd., a subsidiary of the Cape Asbestos Company. The amianthus of the ancients, asbestos has been known " for at least 2,500 years " and its heat-resistant properties have been in continual use for most of that time. Since the middle of last century techniques for furthering the industrial usage of this naturally-occurring mineral fibre have been under constant development. The original amianthus was certainly the serpentine asbestos chrysotile—white asbestos—and the discovery of the vast Canadian deposits some 150 years ago led eventually to the exploitation of the Quebec fields as commercial applications became appreciated. The " Cape Asbestos," however, is of a different type—" blue asbestos " or crocidolite—first noted in the Cape early in the 19th Century and now perhaps having as wide a scale of uses as the original white.

The book under review carries an entertaining introductory section entitled " The Myth : Asbestos in History," which leads naturally to an examination of "The Reality." In this chapter the mineralogical classification of asbestos is discussed and the differences between the two types of fibre explained. Next comes an account of the Cape Asbestos Company's mines in Africa, followed by a review of the vast number of uses that have been found for blue asbestos and the related amosite. This part of the booklet describes mines in the Cape Province and the Transvaal and gives a coloured flow diagram of the production of asbestos, as well as photos of the mines and a map. A final section deals with the commercial applications of amosite and blue asbestos, gives a note on preparation and fiberization, and a summary of grades.

Of particular interest is an account of the Cape Asbestos Company itself. Formed in London in 1893 to undertake the mining of asbestos in South Africa and the manufacture from it of thermal insulation materials in Italy, it has expanded into a group of associated companies manufacturing not only insulation materials from asbestos but also of mineral wool, as well as a range of asbestos-based brake linings. Production of raw asbestos fibre from its own mines in South Africa is still a basic activity of the group, but in 1961 the responsibility for advising on negotiations and sale of all crude and processed fibres was delegated to the subsidiary company Cape Asbestos Fibres, Ltd. Manufactured products of the group are dealt with in separate literature listed in the booklet.

Aerial Survey in Australia

Further progress in airborne survey work in Australia has recently been announced. In a statement regarding the activities of the Bureau of Mineral Resources the Minister for National Development, Senator the Hon. W. H. Spooner, referred to the issue of four maps [1] which show the results of an airborne magnetic and radiometric survey of the Forbes District, New South Wales. The magnetic results are considered of interest, some of the anomalies indicating lines or zones of disturbance which follow the general strike of the regional geological structures ; others are grouped in areas adjacent to masses of granite and may be related in some way to mineralization.

A number of radiometric anomalies have also been recorded although no claim is made that such anomalies correspond to uranium deposits. However, several of them are considered to be worthy of additional investigation on the ground and have been brought to the notice of the New South Wales State Mines Department.

[1] Canberra : Bureau of Mineral Resources. Price 30s. per set.

MONTHLY REVIEW

Introduction.—In spite of the continued tension that exists over the Berlin situation and the fact that atomic tests have been resumed in the U.S.S.R. there is a feeling that some peaceful settlement will eventually be arrived at between the Russians and the Western Powers. In the business world there is evidence of continued recovery in America and hope that the present dullness in metal prices may not be long continued if that recovery is sustained.

South Africa.—The output of the member gold-mining companies of the Transvaal and Orange Free State Chamber of Mines for August totalled 1,926,670 oz. and that of outside companies 40,346 oz., making a total of 1,967,017 oz., a new record figure. The number of natives at work in the gold mines at the end of August was 382,733, as compared with 389,255 at the end of the previous month.

The operations of the LUIPAARDS VLEI ESTATE AND GOLD MINING COMPANY in the year to June 30 last resulted in a profit of £1,224,186, dividends equal to 2s. a share requiring £496,911 of the £1,359,234 available. In the Main Reef section a total of 816,000 tons of ore was milled and 142,524 oz. of gold produced, while the 574,000 tons treated in the Bird Reef section yielded 18,330 oz. of gold and 801,897 lb. of uranium oxide. The ore reserves at June 30 last were estimated as 1,350,000 tons on the Main Reef, averaging 4·6 dwt. and 687,000 tons on Bird Reef averaging 1·6 dwt. per ton in gold with 2·43 lb. of uranium oxide. The report states that " in accordance with the new production policy " lower-grade ore not now expected to be mined by the company has been excluded from the ore reserve. In addition, " in view of the limited information available regarding the Bird Reef horizon south of No. 1 fault, and the costly development that would be required to make this orebody accessible, it is unlikely that the reef in this area will be exploited under existing conditions."

Towards the middle of September shareholders of WEST WITWATERSRAND AREAS were informed that borehole No. 22 on the Farm Doornkloof 350 in the 1st deflection intersected the Carbon Leader at a depth of 10,990 ft. and assayed 0·9 dwt. gold per ton over a corrected width of 54·4 in. In the 2nd deflection the Main Reef was intersected at 10,697 ft. and assayed 0·40 dwt. gold per ton over a corrected width of 7·7 in. A final deflection intersected a band of Kimberley Reef at a depth of 7,017 ft., assaying 2·1 dwt. gold per ton over a corrected width of 39·0 in. In another hole, No. E.8.L on Farm Kleinfontein 141, the Carbon Leader was cut at 9,100 ft., assaying 13·0 dwt. gold per ton over a corrected width of 7·4 in. This confirms as Main Reef, it is stated, a reef intersected in this hole at 8,764 ft., assaying 4·3 dwt. over a corrected width of 9·8 in.

The No. 3 shaft system of PRESIDENT STEYN GOLD MINING, comprising a 26 ft.-diameter hoisting component sunk to 6,255 ft. and a 20-ft. diameter ventilation component sunk to 6,010 ft., should shortly be in full operational duty. This will equalize the hoisting duties of the mine's three shaft systems, two of which have been operating at above normal capacity rates pending the operational commissioning of No. 3, which is equipped with a steel A-type headframe. Benefits from the commissioning of No. 3 will include an extension and acceleration of the development rate, increased stoping and hoisting of ore, and a significant rise in the milling rate.

In the lower-grade zone of FREE STATE GEDULD MINES a borehole in the south-eastern section about 11,000 ft. east of No. 2 shaft has been completed, which in earlier intersections disclosed Basal Reef values of 351 in.-dwt. at 7,479 ft. and in a deflection duplication due to reverse faulting with values of 172 in.-dwt. at 7,479 ft. and 126 in.-dwt. at 7,540 ft. Because of considerable deflection from the vertical a second series of intersections was effected from well above the reef horizon, which did not disclose reverse faulting and which yielded values of 158 in.-dwt., 92 in.-dwt., and 183 in.-dwt. These do not materially affect the average borehole grade for the lower-grade zone of the mine, which is 264 in.-dwt., against 180 in.-dwt. in the borehole mentioned. The south-eastern section has been little explored by drilling and not at all by development, which is being advanced into the section.

WINKELHAAK MINES has completed a borehole in the deeper north-eastern section with

the Kimberley Reef values of 1,685 in.-dwt. and 1,498 in.-dwt. at a depth of 5,333 ft.

Last month the directors of the RAND SELECTION CORPORATION announced the conclusion of arrangements whereby the Corporation had borrowed a total of $(U.S.)30,000,000 (equal to R21,439,240 and £10,719,620) from overseas sources. The loans have been raised privately, it was stated, by the issue of unsecured debentures to certain American institutional investors and, of the total amount, $5,000,000 (equal to R3,589,053 and £1,794,526) is repayable at the end of seven years and $25,000,000 (equal to R17,850,187 and £8,925,093) at the end of ten years.

With the recent dividend notice shareholders of LYDENBURG ESTATES were informed that the profit for the year to June 30 last was £39,431, making with the sum brought in an available total of £52,900, of which £26,631 is required for the dividend of 1s. 3d. per share. It was also announced that the ANGLO AMERICAN CORPORATION OF SOUTH AFRICA proposed to make an offer to stockholders of Lydenburg Estates to exchange their stock units for shares in the ORANGE FREE STATE INVESTMENT TRUST, on the basis of one Ofsit share for every five stock units held. Full details of the offer are to be sent to stockholders as soon as possible, it was stated.

Ghana.—At the extraordinary meeting of the ASHANTI GOLDFIELDS CORPORATION held on September 15 the resolution proposing an increase in the Corporation's capital to £3,000,000 was passed and the issue of 2,497,116 shares of 4s. each to existing holders was also approved. With the announcement of the gold return for September shareholders were informed that the estimated profit for the month was £152,101 and that the estimated total for the year to September 30 was £1,859,753.

It was announced last month that a licence to buy diamonds on the Ivory Coast had been granted to a new subsidiary of the DIAMOND CORPORATION, the DIAMOND CORPORATION COTE D' IVOIRE. The move, it is suggested, has been occasioned by the sharp rise in alluvial diamond production on the Ivory Coast in recent years.

Sierra Leone.—It has been reported that a £7,000,000 development programme is planned to improve port facilities at Pepel and to allow major increases in the iron-ore milling capacity at Marampa. The new project will, it is stated, increase the output of Marampa by about 50%, while a new ship-loading berth at Pepel is to be built to accommodate large ore carriers.

Nigeria.—With the dividend notice issued last month shareholders of UNITED TIN AREAS OF NIGERIA were informed that tin and columbite revenue for the year ended March 31 last totalled £182,223. The profit for the year is given as £9,412, of which the proposed 5% dividend will require £3,203.

Tanganyika.—In the report of the TANGANYIKA DIAMOND AND GOLD DEVELOPMENT COMPANY for the three months ended June 30 last it is stated that in the period 118,084 loads of ground were treated at the Alamasi mine and 5,596 carats of diamonds recovered. Included were five specified stones weighing respectively 38·5 carats, 17·8 carats, 16 carats, 12·2 carats, and 10·6 carats.

Australia.—Reference to the formation of ALCOA OF AUSTRALIA PTY., LTD., was made in the September issue. The new company was formed to establish an integrated aluminium industry, based on Darling Ranges (Western Australia) bauxite and Anglesea (Victoria) brown coal. It was stated that the company would be owned as to 51% by Alcoa and 49% by the Australian partners and advised that the Australian shareholders in WESTERN ALUMINIUM N.L. would receive 4,375,000 fully-paid shares in Alcoa of Australia in consideration for the assets brought to the venture, while Alcoa was to receive 6,250,000 fully-paid shares in consideration for the full and exclusive right to Alcoa of Australia to use, in Australia only, certain secret processes, technical knowledge, and other information relating to the design, construction, and operation of the aluminium facilities. The contributing shares in the venture have now been subscribed, Alcoa having taken up 6,500,000 and the Australian companies collectively 7,875,000 shares. These companies include the WESTERN MINING CORPORATION, NORTH BROKEN HILL, BROKEN HILL SOUTH, and the CUSHION TRUST COMPANY.

An extraordinary meeting of the WESTERN MINING CORPORATION is to be held in Melbourne later this month and it will be proposed that the capital of the company be increased to £5,000,000 by the creation of 16,000,000 new 5s. shares. At the same time, to finance its investment, NORTH BROKEN HILL, LTD., is to make a new issue of approximately 4,200,000 shares of 10s. each at par, which will be offered to shareholders in the proportion of 30 new shares for each 100

existing shares held. Rights to shares of the new issue will be renounceable. BROKEN HILL SOUTH propose the capitalization of £3,200,000 (Aust.) out of assets revaluation reserve, being capital profit arising from revaluation of certain assets of the company which have not been acquired for the purpose of resale at a profit, the appropriation of the above mentioned sum to allot to stockholders four 1s. fully-paid shares (to be converted into stock) for each 1s. unit of stock now held, and then consolidation of capital into 5s. stock units, so that stockholders will then hold one 5s. stock unit in place of each 1s. unit now held. The last-named company has also announced that its consolidated net profit for the year ended June 30 was £804,474, after providing for depreciation, income tax, and New South Wales mining royalty, as compared with £986,508 for the preceding year. Notwithstanding the reduction achieved in cost of mining at Broken Hill the net profit fell because of the lower prices realized for lead and zinc, it is stated.

GREAT BOULDER GOLD MINES has announced slightly lower profits in the year to June 30. The figure announced, £A263,940, compares with £A274,891 for the previous year.

Malaya.—Last month shareholders of TRONOH MINES were informed that at an extraordinary meeting called for October 13 it is to be proposed that the capital of the company be increased to £2,250,000 and that the sum of £1,075,187 10s. standing in part to the credit of the share premium account and general reserve account be capitalized. If the recommendations are adopted, shareholders are to receive one new fully-paid share of 5s. for each share held. The company's profit for 1960 has been reported as £1,174,563, its total production in Malaya being 3,066 tons of tin concentrates.

Shareholders of AYER HITAM TIN DREDGING have been informed that Dredge No. 1 conversion to electric drive, replating of the pontoon, and other modifications have been completed and the dredge is now operating.

With a view to bringing the issued capital of KRAMAT TIN DREDGING more into line with the present day value of the assets employed in the business, the directors recommend that the major part of the assets revaluation reserve be capitalized by way of a free issue to members of full-paid shares on the basis of one new 5s. ordinary share for every 5s. share held, which would absorb £165,000 of the total of £175,529 in the assets revaluation reserve. To achieve this it would first be necessary for the authorized capital to be increased and it is proposed that such increase should be from the present amount of £165,000, all of which has been issued, to £330,000.

British Guiana.—From British Guiana it is reported that during July, 95,151 long tons of bauxite and 15,302 long tons of alumina were shipped by the DEMERARA BAUXITE CO., LTD., and went forward in 27 vessels from the port of Mackenzie, Demerara River. The total shipments by the company for the first seven months of the year were : Bauxite, 873,205 long tons ; alumina 46,723 long tons.

Canada.—It was announced in Canada on September 29 that an offer has been made by RIO ALGOM MINES, LTD., to purchase the technical and administrative organizations of the RIO TINTO MINING CO. OF CANADA, LTD., together with its exploration and development programme and certain other assets. It is a condition of the offer, it is stated, that the RIO TINTO COMPANY, LTD., of London, and its wholly-owned Canadian subsidiary TINTO HOLDINGS, LTD., will, for a period of 15 years refer to Rio Algom all business opportunities in Canada which come to their knowledge and Rio Algom will grant a reciprocal covenant relating to the United Kingdom. It is explained that the transfer of the exploration programme of Rio Tinto Canada to Rio Algom would enable Rio Algom to expand its exploration programme and to take full advantage of the administrative and technical organization built up by Rio Tinto Canada over the years. Rio Algom is also to become the representative in Canada of the Rio Tinto Company for the purpose of taking advantage of business opportunities.

In the report of Placer Development, Ltd., for the year to April 30 last it is stated that an active exploration programme was carried out by CANADIAN EXPLORATION, LTD., directly through the medium of its wholly-owned subsidiary, CANEX AERIAL EXPLORATION, LTD., and indirectly through participation with other companies active in the exploration field, two of these being CENTENNIAL MINES and MAGNUM COPPER in which Canadian Exploration continues to hold a 69·9% and 50·2% interest, respectively. A large number of prospects have been examined, mainly in western Canada, some of which require additional study and further work. The Crown Reserve Drilling Reserva-

tion in the foothills area of Alberta, in which Canex Aerial Exploration retains a 15% interest, is being developed under the direction of the operators, the TEXAS GULF SULPHUR COMPANY.

Czechoslovakia.—It is reported that recent geological surveys in Czechoslovakia have revealed rich deposits of lead, copper, zinc, gold, and iron ores in the area of the Jesenické Mountains, north-west of Ostrava. The occurrencies lie at a depth of more than 6,000 ft. Surveying is to go on in the area. Elsewhere, two new mines are being opened, one on Horní Benešov and the other in the Zlaté Mountains. Trial operations are due to commence in the Horni Benešov mine next year and full-scale extraction of lead and zinc will commence in 1963. The Zlaté Mountains mine will extract lead, zinc, copper, and gold.

Placer Development, Ltd.—The consolidated accounts of Placer Development, Ltd., and its subsidiary companies for the year ended April 30 last shows a profit of $2,735,303, which increased the credit balance brought in to $21,416,666; of this amount dividends equal to 70 cents a share require $1,806,000. Earnings in the three months ended July 31 have now been reported as $585,672.

DIVIDENDS DECLARED

* Interim. † Final.

(Less Tax unless otherwise stated.)

***African and European Investment Co.**—20 cents, payable Nov. 16.

***Anglo American Corporation of South Africa.**—40 cents, payable Nov. 16.

Apex Mines.—Half-yearly, 5½ cents, payable Oct. 25.

†**Bancroft Mines.**—1s. 3d., payable Dec. 7.

†**Blinkpoort Gold Syndicate.**—26½ cents, payable Nov. 8.

Broken Hill Proprietary Co.—Half-yearly, 7½d. Aust., payable Nov. 29.

***De Beers Consolidated Mines.**—Def. 50 cents, payable Nov. 1.

†**Free State Geduld Mines.**—50 cents, payable Nov. 8.

†**Harmony Gold Mining Co.**—14 cents, *plus* reduction of share premiums 3 cents, payable Nov. 8.

†**Kalgoorlie Electric Power.**—10%, payable Oct. 18.

Kepong Dredging Co.—Non-taxable distribution 2s., payable Nov. 14.

***Lydenburg Platinum.**—8 cents, payable Nov. 6.

†**Mount Isa Mines.**—9d. Aust., payable Dec. 29.

Ndola Copper Refineries.—10%, payable Dec. 16.

†**Potgietersrust Platinums.**—8½ cents, payable Nov. 6.

†**President Brand Gold Mining.**—30 cents, payable Nov. 8.

†**President Steyn Gold Mining.**—7½ cents, payable Nov. 8.

†**Rhodesian Anglo American.**—10s., payable Dec. 7.

†**Rhodesian Selection Trust.**—9d., payable Dec. 18.

†**Rhokana Corporation.**—9s. 2d., payable Dec. 7.

Rio Tinto Company.—Half-yearly, 5% pref., 2s. 6d., 5½% second pref., 2s. 9d.

†**Roan Antelope Copper Mines.**—8d., payable Dec. 16.

†**Selection Trust.**—4s., payable Dec. 18.

†**Tanganyika Concessions.**—1s. 9d., payable Jan. 31.

***Union Platinum Mining Co.**—13⅜ cents, payable Nov. 6.

†**Wankie Colliery Company.**—9d., payable Dec. 4.

***Waterval (Rustenburg) Platinum Mining Co.**—14½ cents, payable Nov. 6.

†**Western Holdings.**—60 cents, payable Nov. 8.

†**Yarra Falls.**—7·2d. Aust., payable Oct. 27.

METAL PRICES

Oct. 6.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	180	0	0
Antimony (Eng. 99%)	230	0	0
Chromium (98%–99%)		7	2½
Nickel (Home)	660	0	0
Platinum (Refined)	30	5	0
Silver		6	7¾
Gold	12	10	1½
Wolfram (U.K.)		—	
(World)	6	0	0

Tin, Copper, Lead, Zinc } See Table, p. 240

The Kolm Deposits of Sweden

C. F. Davidson [1]

A study of a geological date-line

Introduction

Despite the many papers recently published on the world's sources of uranium, one of the most remarkable deposits has yet to be fully described. The radioactive carbonaceous matter known as "kolm" which is present as thin seams and lenses in the Cambrian oil shales of Sweden is referred to briefly in most text-books on radiogeology, but no comprehensive account of the field relations and geochemistry of this unusual substance has hitherto appeared. Interest in kolm is two-fold. First, the rock forms an extensive though probably sub-economic source of uranium. Second, it appears to provide a radioactive datum level interstratified with fossiliferous deposits, from which the absolute age of the Cambrian system has been deduced. Since the reliability of age determinations founded on studies of kolm can scarcely be assessed without a full knowledge of the mode of occurrence and manner of origin of the rock, the writer ventures to supplement recent geochronological studies by some observations based on a field investigation made many years ago, in the hope that they may stimulate further publication.

Mineralogically, kolm is an impure uraniferous hydrocarbon in which the uranium is present not as a discrete phase but rather as an adsorption or an organo-metallic compound held by the carbonaceous matter. It thus differs from thucholite or carburan, formed of separate uraninite and hydrocarbon phases readily distinguishable under the ore microscope; and probably its nearest analogue is to be found in the uranium-bearing hydrocarbonaceous matter of uraniferous coals. Like kolm, the Cambrian alum shale in which it occurs is uraniferous, though to a much lower degree—about 0·02% opposed to an average value of about 0·45% U_3O_8. To assist an understanding of the origin of kolm it is appropriate to give a short account of the shale in which it is found.

The Alum Shales

In Sweden, alum shales or oil shales are developed in the provinces of Västergötland, Närke, Östergötland, Skåne, and in the island of Öland. They are, for the most part, of Cambrian age, but the lowermost (Middle) Cambrian shales, the *Paradoxides* shales, are too poor in oil to be of any economic interest and the commercial output has been derived solely from the *Olenus* shales of the Upper Cambrian. In Östergötland the *Dictyonema* oil shale horizon of Lower Ordovician age is also present but is of no significance in connexion with kolm. An extensive literature has been published by the Geological Survey of Sweden.

The shales have been worked since the 17th Century. The earliest workings were for the manufacture of alum, but for well over a hundred years the rocks have been quarried as a source of fuel for the burning of limestone—the limestone occurring both as large rounded concretions and banks of *orsten* or stinkstone (bituminous limestone) within the shale itself, and as the massive *Orthoceras* limestone of Ordovician age which immediately overlies the horizontally bedded shales in many districts. In more recent times the shales have also been used as fuel for several cement factories in Västergötland, and latterly as a source of Ytong, a patent building material. For the production of oil, only those deposits with an oil content in excess of 4% have been exploited, the industry being confined to the Kinnekulle district of Västergötland and to part of the province of Närke. There is no apparent correlation between oil yield and content of kolm. In the Billingen-Falbygden district of Västergötland, where kolm is best developed, the shales yield only about 1·8% oil. At Kinnekulle and again in Östergötland, where kolm is rare, the oil content exceeds 4%. In

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the shales worked for oil in Närke, however, kolm is present in relatively large amount.

The alum shales are richer in uranium than any other sedimentary rock of wide extent, the average recorded value for the mid-Upper Cambrian horizons being about 200 g. U_3O_8 per ton. According to Bates and Strahl (1958) an average of 309 samples gives 0·0168 % U with a standard deviation of 0·0254 % U. The shales also show a comparably high tenor of vanadium, tungsten, molybdenum, nickel, zinc, copper, and other heavy metals. These elements are undoubtedly syngenetic with the sediments in which they occur and have been scavenged by sorption from sea water, the high tenor being indicative of very slow deposition. Similar contents of the non-radioactive metals are to be found in the bottom deposits of the Black Sea (Strakhov, 1960), for which unfortunately uranium data are not available.[1] Like the Black Sea sediments the shales contain much sulphur (6–7%), now present as melnikovite or pyrite, presumably deriving from bacterial action under euxinic conditions. On oxidation and lixiviation this sulphide yields the alum from which the shales take their name.

Interesting conclusions derive from experimental work to determine the mineralogical form in which the heavy metals occur in the shales. Assarsson (1943) has demonstrated that a considerable part of the vanadium, tungsten, and molybdenum present is associated with colloidal iron sulphide, and a contemporary unpublished German report of unknown authorship, which came into the writer's possession in 1945, shows that a thirty-fold increase in uranium can be obtained in gravity concentrations of gel pyrite or melnikovite. Crystalline pyrite, however, was found to contain no uranium ; and a flotation concentrate of carbonaceous matter contained no more uranium than did the parent shale. These conclusions have been confirmed by more recent investigations in Sweden, including a published study by Rynninger (1957) who finds that uranium is not concentrated in the organic phase of the rock. Apparently the uranium is associated with two carriers : one of these is gel pyrite or melnikovite, occurring partly in clusters with crystalline pyrite, partly as a uniform dispersion throughout the shale ; and the other is the hydrocarbonaceous matter. The latter, however, has only a low tenor, in this contrasting markedly with the kolm nodules. The shales are low in phosphate : had it been otherwise a concentration of uranium would doubtless have occurred in collophane nodules which, when found in black shales, are preferentially hospitable to this element.

[1] Since this was written a surprisingly low average value of $5{\cdot}7 \times 10^{-4}$% U has been reported for Black Sea deep-water sediments by Starik and others (*Doklady Akad. Nauk*, July 1961, v. 139, p. 457).

The Kolm

The kolm forms small lenticular nodules and thin seams in the alum shale, exceptionally up to 20 cm. in maximum thickness but averaging 4 or 5 cm. thick. Usually two distinct bands are visible, from 2 to 3 metres apart. The habit of occurrence varies somewhat from place to place. Most commonly the hydrocarbon forms a discontinuous chain of lenses which in quarrying split off readily from the shale matrix. As recently as 1945 when the writer visited the deposits these lenses (containing around half a per cent. U_3O_8 !) were being saved by the quarrymen for use as household fuel (Fig. 1). Elsewhere the lenses unite into a continuous seam. For example, at Skår in the Billingen region the upper seam of kolm, ranging from 3 cm. to 6 cm. in thickness, can be traced almost without interruption along a continuous line of quarries for some 700 m. to 800 m., always maintaining exactly the same horizon in the oil shales. A lower, thinner, seam is more lenticular (Fig. 2).

Nearly all the kolm is confined to one stratigraphical belt, from 2½ m. to 3 m. thick, lying roughly between 3 m. and 8 m. from the top of the oil shale series. Within this belt about 1·5% of the thickness consists of kolm. The distribution is not at a constant palaeontological horizon. Although most of the kolm occurs in the zone of *Peltura scarabæoides*, the main development in the Närke district, according to Westergård (1922), is in the lower part of this zone at Latorp, in the middle part of Yxhult, and in the middle and upper parts at Lanna. Again, according to the same authority, the mineral occurs in Falbygden in the lower part of the zone of *P. scarabæoides* but in the adjacent district of north Billingen it is found in the uppermost part of the underlying zone of *P. minor*. Clearly, therefore, there is no precise stratigraphical equivalence between the various occurrences.

From a comparison of the chemical analyses listed in Table 1, it will be seen that the kolm and the oil shale are quite dissimilar in character. Even if calculated ash-free the analyses differ greatly, particularly in the

Fig. 1.— Kolm Nodules on a Quarry Floor.

ratios of sulphur and of nitrogen to carbon which are many times greater in the shale. In appearance there is no similarity between the two rocks. The kolm (sp. gr. 1·5) is bright black, rather resembling cannel, massive but somewhat splintery and with a marked conchoidal fracture, without any trace of bedding or lamination ; the oil shale (sp. gr. 2·2) is dull black or grey, markedly laminated, and fissile.

Table 1

Analyses of Kolm and Oil Shale

	I	II	III	IV
Moisture . .	4·85	—	1·5	1·3
Carbon . .	60·24	55·61	13·8	17·7
Hydrogen .	4·64	3·93	1·5	2·0
Nitrogen . .	0·50	0·27	0·35	0·35
Sulphur . .	3·99	7·63	6·7	6·8
Ash . .	22·88	31·11	76·0	72·7
Calories/kg. .	5,780	—	1,600	2,050

I. Kolm, Karlsro, Västergötland. Quoted from Winkler, *Zeits. f. Kryst.*, **37,** 1903, 287.

II. Kolm, Gullhogen, Västergötland. Quoted from Holmberg and Unnerstad, *Handl. Ingeniörsvetenskapsakad.*, **16,** 1923, 71.

III. Oil shale, Kinnekleva. Quoted from Sundius, *Teknisk Tidskrift*, 1942.

IV. Oil shale, Yxhult. Quoted from Sundius, *ibid.*

The presence of noteworthy quantities of uranium in kolm was first demonstrated by Nordenskiöld (1893) in investigations which also revealed the presence of another uraniferous hydrocarbon (now known as thucholite) in some Swedish skarn iron ores. Modern autoradiographic investigations using nuclear emulsions have since shown that the uranium in kolm is dispersed rather evenly throughout. Some uranium is associated with colloidal sulphide (Ross, 1950) but there is no discrete mineral phase giving a strong star-like distribution of alpha particle tracks as is found around the uraninite grains in thucholite. The uranium content is variable. In more than 50 analyses available to the writer, mostly unpublished, the range is from 0·14% to 0·64% U_3O_8, with an average value of 0·45%. In kolm ash, the tenor ranges in 16 analyses from 0·47 % to 2·91% U_3O_8 ; and as the richest specimens are those with the lowest ash content there can be no doubt that the uranium is contained in the hydrocarbon. In most nodules the content of ash increases towards the periphery, with an accompanying decrease in the tenor of heavy metals. Different specimens from the same locality may show widely differing contents of uranium. Vanadium is present in significant amount but is subordinate to uranium ; a recent analysis (Cobb and Kulp, 1961) shows 0·22% V_2O_5.

From time to time attention has been give to kolm as a potential economic source of radioactive elements of the uranium series. In 1909 the Aktiebolag Kolm was formed, with a capital of 700,000 kronor, to extract radium. A factory was erected at Islinge near Lidingön, a north-eastern suburb of Stockholm, at which it was planned to process 1,000 tons of kolm per year, yielding 4·5 g. of radium bromide—a significant quantity at a time when a gram. of this salt had a value of 300,000 kronor. The kolm was derived from Lilla Stolan at the north end of Billingen. During 1910 about 200 tons of kolm was worked up at the Islinge plant, but it was found that the radium which could be recovered corresponded to only a fraction of

that theoretically available. In 1911 the operation was re-organized with additional subscriptions of 90,000 kronor, but further research work failed to discover a suitable commercial process for the extraction of the radium and the company went into liquidation in 1915. In part the economic difficulties arose from a radioactive disequilibrium (radium deficiency) in the kolm. The Swedish analyst Mauzelius (1914) observed at this time that the radium content is only 60% to 70% of what it should be if reckoned from the yield of uranium.

Since 1945 kolm, together with the shales in which it is found, has been developed as a commercial source of uranium, but so far as the writer is aware no comprehensive account of these recent studies has yet been released.

The Origin of Kolm

Some years ago, in a passing reference to kolm, the writer expressed the opinion that this carbonaceous matter did not originate as a sediment co-eval with the oil-shales in which it occurs, but that it came about as "a penecontemporaneous segregation of sapropelic gel, formed in the partially consolidated shales by some unexplained process of colloid chemistry, its mode of origin perhaps being not dissimilar to that of the flint layers in chalk which it rather resembles in mode of occurrence" (Davidson, 1951). A contrary view has lately been expressed by Cobb and Kulp (1961) who accept that the mineraloid "was formed in shallow water (where) sluggish, swirling currents acted so as to collect organic matter into small depressions in the sediment. Later, during lithification, the organic material compacted together and flattened out into the lens-like form seen today." A clarification of concepts on the origin of kolm thus seems overdue. Several lines of evidence contradict the latter syngenetic hypothesis.

First, consider the geological environment. The sea in which these Upper Cambrian shales were deposited extended from western Russia to Britain and beyond, and the relatively thin deposits of central Sweden, with the highest ratio of organic to inorganic matter, were presumably laid down farthest from land where the rate of sedimentation was very slow. The combined thickness of the almost complete Upper Cambrian sequence in Västergötland is no more than 20 m., at a rough estimate representing less than 2·5 cm. of sediment per 10,000 years. Although the kolm may locally extend as an uninterrupted seam for 700 m. to 800 m. at the same stratigraphical level, it in general varies in precise palaeontological horizon from place to place. A hypothesis of strictly syngenetic deposition thus requires conditions in the open sea which permit very prolonged sedimentation of organic matter in quite small areas largely devoid of inorganic detritus, whilst normal sedimentation is going on all around. This requirement is manifestly unattainable.

Second, the geochemical evidence is instructive. The environment of deposition of the shales is typically euxinic and, as is well known, such bottom conditions are particularly hospitable to sulphate-reducing bacteria, giving syngenetic sulphides wherever much organic matter is present. The alum shales are, in fact, a minor industrial source of sulphur. If the kolm were formed by organic sedimentation on the sea floor one would expect it to display at least as great a sulphur : carbon ratio as do the shales. Relative to carbon, however, both the sulphur content and the nitrogen content of the kolm is consistently very much less than that of the shales, indicating a genetic dissimilarity between the two rocks.

Third, it is significant that the uranium content of kolm is consistently many times greater than that of the hydrocarbonaceous matter in the alum shales. If the two hydrocarbons are of similar origin this difference is inexplicable.

The alternative view, that the kolm postdates the period of sedimentation and has come about by accretionary growth, is attested by the common lensoid form, rather resembling the shape of clay-ironstone nodules. Unlike septaria, however, there are no syneresis cracks. The flattened, lenticular, form together with the absence of syneresis suggests that the kolm originated as a non-aqueous gel of hydrocarbonaceous matter, different in composition from the common hydrocarbon of the shale.

It is not possible, on present evidence, to suggest the original nature of the kolm gel. Recent studies on the Quaternary sediments of the Black Sea and similar basins have demonstrated that during the late diagenesis of black shales a part of the organic matter, usually less than a tenth of the total, may become transformed into petroleum-type hydrocarbons, whilst the remainder forms a less mobile kerogen with a higher nitrogen and oxygen content. If some such transformation took place during the diagenesis of

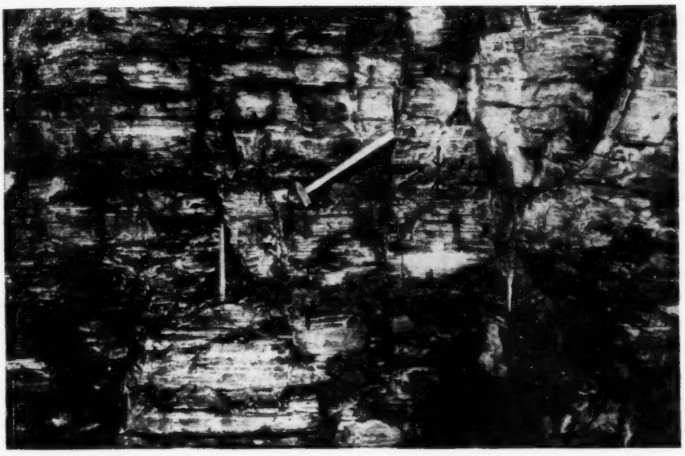

Fig. 2.— Kolm Seams in Alum Shale.

the alum shales, the more mobile hydrocarbons would tend to aggregate together when hydrostatic equilibrium was disturbed. Their assembly into the pods of kolm could have occurred during the regional uplift marked by a disconformity in the uppermost Cambrian, the rather uniform stratigraphic disposition reflecting the uniform tectonic conditions throughout the field. On destructive distillation the kolm gives less oil than the shales (Swanson, 1960), but a decrease in the hydrogen : carbon ratio, tending towards solid carbon, would be a natural result of irradiation by the contained radioactive elements.

Nevertheless there is good reason to believe that kolm was not a petroleum-type hydrocarbon, for, as recently demonstrated by Bell (1960) and Hyden (1961) of U.S. Geological Survey, crude oils are not effective agents in extracting uranium from sedimentary ores or from aqueous solutions. In another of the recent outstanding studies by U.S.G.S. officers, Swanson (1960) very tentatively suggests that kolm may represent coagulated humic acids, which are particularly hospitable to uranium and which would readily form a gel in the slightly alkaline environment of the shales. Unfortunately difficulty arises in explaining the source of humic type organic matter in strata of this early date and in sediments deposited far from land. Slight support for this view is to be found, however, in the similarity in mode of occurrence between kolm and Whitby jet, referred to below, the humic origin of some specimens of jet being probably demonstrable.

The date of fixation of uranium in the kolm pods is an important question in relation to geochronological studies. The decisive arguments against a syngenetic origin for kolm rule out the naive view of Wetzel (1947), accepted by Cobb and Kulp (1961), that for some unexplained reason the Upper Cambrian organisms had a special affinity for uranium. It seems a reasonable conclusion that at the time the nodules were formed some part of their contained uranium must have been extracted from the sediments by the migrating hydrocarbons ; but if the kolm hydrocarbon was hospitable to uranium then, it must have continued to be so long afterwards. One can assume that just as a fossil bone, a nodule of phosphorite, or a pocket of vegetable trash will gradually over a long period accrete uranium from percolating waters, so the kolm pods continued to do so, in marked amount during the principal period of diagenesis and in lesser degree with the passage of time.

It has been suggested above that the kolm nodules were most probably formed during diagenesis towards the close of Upper Cambrian times. The diagenetic reconstruction of the alum shales has been very extensive. Although interbedded with banks of limestone, the shales are almost carbonate-free, due to the removal of calcium carbonate during diagenesis to form large concretionary doggers of anthraconite. This secondary bituminous calcite, often coarsely crystalline and sometimes containing pockets of non-radioactive bitumen, is centred upon nuclei of primary limestone rich in well-preserved trilobites. Unless it is accepted that this large-scale diagenesis took place under a

cover of no more than a few feet of overlying sediment (excluding the water content), which is most unlikely, we must conclude that these processes continued into the Ordovician period and that there were widespread chemical changes in the shales, and ample opportunity for the kolm pods to soak up uranium, long subsequent to Cambrian times.

The similarity between kolm and jet has not previously been remarked upon. Some foreign jets are doubtless compact lignite; but English jet, once widely worked as a semi-precious stone from the Upper Lias shales of Whitby in Yorkshire, parallels the Swedish mineraloid too closely for the resemblance to be fortuitous. Whitby jet was mined from pyritous oil shales, one horizon of which formed the basis of an alum industry founded in Tudor times. It occurs as seams of tabular or lensoid nodules, generally smaller and less persistent than kolm pods, found a little below nodular bands of concretionary limestone doggers which, like the *orsten*, sometimes enclose mineral oil. No recent microscopic study of jet is known to the writer. According to Fox-Strangways (1892), some early authors have demonstrated the presence of a woody structure in the masses of jet " whilst others state with equal confidence that there is no trace of organic structure in these blocks, but that they are due to the segregation of bitumen from the surrounding shales." Both the shales and the jet have a negligible uranium content, but jet ash may contain more than 4% vanadium oxide, which has presumably accreted in the same manner as the uranium in kolm.

The Geochronology of Kolm

There is an extensive geological literature on the absolute dating of Upper Cambrian times based on the tenor of uranium and lead in kolm and on the isotopic composition of these metals. All the papers tacitly accept the debatable assumption that kolm was formed when the associated trilobites were still alive. The earlier work has been reviewed by Cobb and Kulp (1961) and need not be referred to here. The recent study of the latter authors is one of the most comprehensive geochronological investigations ever to be undertaken, and it lists determinations of apparent age for 18 samples of kolm, all of which show the same general discordancy. The pattern of the data, for three typical specimens, is shown in Table 2. The discordant ages are explained as being due to selective removal of Pb^{206}, arising in part from the movement of an intermediate member of the U^{238}/Pb^{206} series and in part from the removal of bulk radiogenic lead. By graphical methods it is deduced that the age of the formation is greater than, though probably not much greater than, 500 m.y., a figure in good agreement with current ideas on the geological time scale; but it is concluded that despite its well-defined stratigraphy kolm does not provide a satisfactory calibration point for an absolute chronology. The latter conclusion is very fully supported by lines of evidence additional to those adduced in the recent study.

Table 2

Age Determinations on Kolm

(*millions of years*)

Locality: Bjallum	U^{238}/Pb^{206}	U^{235}/Pb^{207}	Pb^{207}/Pb^{206}
Edge of nodule .	365	435	920
Centre of nodule	370	425	770
Edge of nodule .	255	435	945

First, Cobb and Kulp accept that there is no likelihood of the kolm pods having acquired their uranium gradually over geological time. They agree that uranium introduction could explain the discordant age pattern as readily as loss of radiogenic lead enriched in Pb^{206}, but rule out this possibility on the grounds (*a*) that there is no preferential concentration of uranium at the periphery of the kolm nodules, and (*b*) that U^{238}/Th^{230} ratios show that uranium introduction is not taking place to-day. The first argument is clearly unacceptable since in phosphate nodules, wood trash and other sorbents which have acquired uranium, germanium, and other elements by accretion from groundwaters the metals do not usually occur in peripheral concentrations but are distributed uniformly throughout. Argument number two is invalidated on two counts. Even if uranium were introduced into kolm at a uniform rate since Upper Cambrian times (much more probably the sorption falls off in a crudely exponential fashion) the amount taken up in the last 500,000 years would affect the U^{238}/Th^{230} ratio by less than the determinative error. Again, one cannot ignore the circumstance that the kolm samples studied came from strata well above the water table, which now lies in the Lower Cambrian sandstones. A material change in the groundwater regime of these sediments has occurred in Quaternary times, and

present-day geochemical conditions cannot therefore be extrapolated unreservedly to the more remote geological past.

Second, the recent studies have shown by isotope measurements that the kolm is markedly deficient in radium and its daughter elements relative to uranium, the deficiency being greater towards the margins of the lenses. It has been suggested that this is due to accelerated surface leaching on exposure at outcrop. This radium deficiency was, however, demonstrated nearly half a century ago both in the analytical work of Mauzelius and the abortive commercial operations of Aktiebolaget Kolm ; and since the kolm ore for this project was mined, the deficiency in daughter elements cannot be attributed to surface alteration. Surface weathering of highly pyritic rocks, with production of sulphuric acid, must give rise to an enrichment rather than an impoverishment in radium : uranium ratios. One must therefore conclude that the missing daughter elements were leached away, in a reducing microclimate, during Quaternary times, perhaps on post-glacial uplift or on the fall of the water table. Throughout the history of the deposits there must have been many occasions when the groundwater regime was similarly disturbed—when the overlying post-Silurian basic sills were intruded, for example, or during the post-Silurian faulting. The not infrequent association of radium-rich waters with black shale deposits and with oil fields throughout the world clearly indicates that such daughter elements are readily leachable. Accordingly one may reasonably postulate an *irregular* extraction of daughter elements from the kolm throughout its history, leading to an impoverishment in radiogenic lead.

There is thus every indication that throughout its life kolm must have formed an open system, with epigenetic introduction of uranium from the shales, and with spasmodic losses of daughter elements. These considerations bring us to a manifest conclusion that kolm is valueless as geochronological datum level.

Summary

The nodular, uranium-rich, carbonaceous material known as kolm, found in the Upper Cambrian alum shales of Sweden, has most probably originated as a hydrocarbon gel during the diagenesis of the shales, probably in latest Cambrian but possibly in Ordovician times. A description of the occurrences is given and an analogy is drawn with the vanadium-rich jet concretions found in the Kimmeridgian alum shales of Yorkshire. There is a strong presumption that the uranium in kolm has accreted by epigenetic introduction from the shales and that losses of radium and radiogenic lead have occurred at more than one period. These conclusions invalidate the use of kolm as a date-line in absolute chronology.

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R.S.M. Register

A handbook has just been published which should prove useful to many companies' offices. This is the fifth edition of the Register of Old Students of the Royal School of Mines, 1961. It contains 2,805 names with biographical details in as many instances as possible. The editor, Dr. J. H. Watson, who is Chemist and Assayer at the Royal Mint, is to be complimented on a considerable compilation. The price is 25s., *plus* postage.

Controlled Swivel for Wire Ropes[1]

A. Seetharam, B.Sc., B.E., M.I.E.

Experiences with deep winds on the Kolar Gold Field are described.

Practice on Mines Abroad

It is understood that in South Africa, until about 1949, to obviate excessive torsion in winding ropes Rand engineers were using " dead lay " ropes. The dead lay is achieved in manufacture by the introduction of an extra idler in the final stage of strand production whereby a permanent set is put into the strand at intervals according to the strand pitch required for the final rope lay up. The tendency for a rope to twist is said to be thus minimized. Where a new rope was found to be " lively " after having been placed on the drum the practice of running a heavily-loaded conveyance down the shaft on the double was used to improve coiling.

It may be pointed out that it was not the general practice with them to release certain number of turns from a new long rope, but where a rope was very " lively " the skip or cage was brought to the surface and the rope released so that the spin could occur on the length between the sheave and bank. This may be done once daily for the first week and subsequently once per week for the next month. This practice was said to be a rare occurrence, as the release of spin is deprecated except where locked-up torsion at the cappel end becomes excessive.

To prevent spin when skip-cage changing occurred a special grip was used.

Even though spin was not released on these ropes it is learnt that a considerable increase in pitch of the strands took place after a few weeks operation, the pitch increasing in length gradually and uniformly from the splice upwards to the point where the rope reached the drum, which is, of course, the point of greatest load. On a typical rope in a winder at Simmer and Jack, similar to Gifford's, the pitch increased from 14 in. (which was the initial pitch) at the cappel end to a maximum of 21 in. at the drum end. After a few weeks operation no further appreciable movement of pitch took place.

[1] Continued from the September issue, p. 150.

It is learnt that in Canada, although releasing spin was not considered desirable, most of their mines found it usually necessary and were doing so. The operation was said to be controlled and just enough spin to permit efficient operation of conveyance was removed from a new rope.

Summary

It is clear from the foregoing that, although it would be ideal and beneficial not to release any spin from a newly-installed rope, working conditions prevailing where chain suspensions are used make it necessary to remove the minimum number of turns to facilitate normal working. A reference to Appendix A and B will show that although the first and third pairs of ropes were manufactured to the same specification (by the same firm) the third pair did not give the same service as the first pair, as the former was over-swivelled by the use of a ball-bearing swivel and actually gave room for anxiety from the very beginning due to looseness of strand etc. A serious accident due to failure of one of these ropes was averted by the vigilant care of the mine staff. The damage to a rope by the use of a ball-bearing swivel was further proved by the performance of the fourth pair of ropes. While it is agreed that the friction swivel was the better equipment to release twist nevertheless there was no control possible in this release and therefore a controlled swivel was obviously necessary.

The sixth pair of ropes, on which a controlled swivel was used, gave the best performance so far in service and shaft horse-power hours of work done.

The seventh pair of ropes on which the controlled swivel was used and the spin released at the bottom of the shaft has been the ideal expected and achieved so far. The advantage of this practice is reflected in the figures for average increase in pitch and maximum extension percentage which are the lowest for all the ropes installed. While the maximum lay pitch on a rope on the South

Appendix A

Particulars.	*First, third and fifth sets.*	*Second and fourth sets.*	*Sixth set.*	*Odd rope put on after a winding accident.*	*Seventh set.*
Length of rope	7,300 ft.	7,300 ft.	7,250 ft.	7,300 ft.	7,250 ft.
Nominal diameter	1⅛ in.	1⅛ in.	1⅛ in.	1·940 in.	1⅛ in.
Construction	Preformed flattened strand	Preformed flattened strand	Preformed flattened strand	Preformed flattened strand	Preformed flattened strand
Type of lay	Lang's	Lang's	Lang's	Lang's	Lang's
Pitch of lay	13 in.	14·5 in.	14·5 in.	15·29 in.	14·4 in.
Handling of lay	Right	Right	Right	Left	Right
Class of core	Manilla	Manilla	Fibre	Manilla	Manilla
Number of strands	6	6	6	6	6
Composition of strands	14 outer wires over 12 inner wires over 6 triangular core with 3 fillers	13 outer wires over 12 inner wires over 6 core wires twisted.	14 outer wires over 12 inner wires over 6 core twisted wires with 3 fillers.	14 outer wires over 12 inner wires over 6 core twisted wires with 3 fillers.	15 outer wires over 12 inner wires over 6 core twisted wires with 3 fillers.
Diameter of wires :					
Outer	0·118 in.	0·126 in.	0·118 in.	0·117 in.	0·112 in.
Inner	0·086 in.	0·084 in.	0·086 in.	0·086 in.	0·089 in.
Core	0·078 in.	0·075 in.	0·078 in.	0·080 in.	0·075 in.
Fillers	0·054 in.	—	0·054 in.	0·058 in.	0·060 in.
Grade of Steel	Extra special improved plough acid steel.	Extra special improved plough acid steel.	Special acid ungalvanized.	Galvanized extra special improved plough.	Extra special improved plough special acid grade.
Tensile strength	126/137 tons	129/140 tons	128/140 tons	130/140 tons	130/140 tons
Guaranteed breaking load of finished rope	176·96 tons	178 tons	180·8 tons	170 tons	185·7 tons
Approximate weight per ft.	6·33 lb.	6·26 lbs.	6·32 lb.	6·28 lb.	6·07 lb.
Approxinate total weight	23·105 tons	22·849 ton	22·91 tons	22·92 tons	22 tons

Appendix B

Pair No.	Initial pitch in.	Swivel used	East rope—Pitch—Installed				West rope—Pitch—Installed				Life		Shaft h.p. hr.	Remarks.
			Mean in.	Average increase in.	Average increase %	Max. extn. %	Mean in.	Average increase in.	Average increase %	Max. extn. %	Yr.	Days		
First . .	14·0	Friction	18·63	4·63	33·07	63·4	18·43	4·43	31·6	67·9	3	77	5,028,005	
Second .	17·75	Friction	21·28	3·53	19·8	46·0	22·32	4·57	25·8	56·0	3	36	3,324,878	
Third . .	14·5	Ball bearing	21·84	7·34	50·6	91·5	22·22	7·72	53·2	93·5	2	18	2,992,039	Lower shaft h.p. than fourth set due to strikes, fire, etc.
Fourth .	15·5	Ball bearing	23·91	8·41	54·2	102·0	23·23	7·73	49·9	97·2	1	349	3,678,684	
Fifth . .	14·0	Friction	19·46	5·46	39·0	67·7	19·10	5·10	36·4	68·3	3	20	5,738,894	
Sixth . .	14·75	Controlled	18·26	4·11	27·9	57·2	19·09	4·34	29·4	62·7	3	250	5,919,444	Swivelled as in (first).
Seventh .	14·50	Controlled and swivelled at 70th level	17·82	3·32	22·9	45·3	17·57	3·07	21·2	44·5	In service.			Swivelled at bottom of shaft.

Appendix D1

Swivelling Observations—Gifford's West Rope No. 378

Observation No.	*Depth below shaft collar ft.*	*Torque gauge pressure lb./sq. in.*	*Torque release No. of turns*	*Rope extension ft.*	*Residual torque*		*Rope lay pitch at shaft collar in.*	*Diam. of rope at shaft collar in.*		*Remarks.*
					Torque gauge pressure lb./sq. in.	*Torque lb.-ft.*		*Max.*	*Min.*	
1	0	100	—	—	—	—	15·68	1·90	1·84	Cage suspended with swivel, etc.
2	550	100	—	—	—	—	—	—	—	No change in pressure. No release.
3	1,100	100	—	—	100	200	15·26	1·90	1·87	Flicked swivel by power.
4	1,650	100	—	—	—	—	—	—	—	No change.
5	2,200	130	—	0 ft. ½ in.	130	260	15·70	1·91	1·87	Flicked swivel by power. Pressure went up to 30 p.s.i.
6	2,750	140	—	—	—	—	—	—	—	Flicked swivel by power. No change.
7	3,300	140	—	—	—	—	—	—	—	No change.
8	3,646 (40 L.)	170	—	0 ft. 1½ in.	170	340	15·85	1·90	1·85	Flicked swivel by power. Not much change.
9	0	160	—	—	160	320	—	—	—	Cage sent up to surface at 500 ft./min.
10	3,646 (40 L.)	160	—	—	160	320	—	—	—	Back to 40 th level. Flicked swivel by power. No change.
11	4,400	170	—	0 ft. ½ in.	170	340	—	—	—	Flicked swivel by power.
12	4,950	170	—	0 ft. 1 in.	180	360	—	—	—	Do.
13	5,500	180	—	0 ft. 2 in.	200	400	—	—	—	Do.
14	6,050	100	—	0 ft. 3 in.	210	420	—	—	—	Do.
15	6,556 (70 L.)	270	—	—	260	520	17·77	1·90	1·82	
16					200	400	18·55	1·90	1·85	
17					160	320	20·15	1·91	1·85	
18			834·6	79 ft. 6 in.	125	250	20·73	1·93	1·85	
19					125	250	20·78	1·92	1·85	Cage sent up to surface and down to 70th level at 1,000 ft. per minute.
			834·6	80 ft. 2½ in.						

Appendix D2

Swivelling Observations—Gifford's East Rope No. 379

Observation No.	*Depth below shaft collar, ft.*	*Torque gauge pressure lb./sq. in.*	*Torque exerted by rope lb./ft.*	*Torque release No. of turns.*	*Rope extension ft.*	*Residual torque*		*Rope lay pitch at shaft collar, in.*	*Diam. of rope at shaft collar, in.*		*Remarks.*
						Torque gauge pressure lb./sq. in.	*Torque lb.-ft.*		*Max.*	*Min.*	
1	3,646 (40 L.)	—	—	—		210	420	—	—	—	Flicked swivel motor and the pressure shot up
2	6,556 (70 L.)	180	—	—		270	540	17·00	1·90	1·86	Do.
3						210	420	18·30	1·90	1·86	
4						200	400	18·48	1·90	1·86	
5						160	320	19·15	1·90	1·85	
6						140	280	20·55	1·92	1·85	
7						125	250	20·72	1·92	1·86	
8						122	244	20·95	1·92	1·85	Cage was brought up to surface and taken down to 70th L. at 1,000 ft. per minute.
				824·9	82 ft. 9 in.						

African winder from which no spin at all was released was 21 in. (with initial pitch of 14 in.), the maximum lay pitch on this pair of ropes has been 21·07 in.—with an initial pitch of 14·50 in. This shows that better results are achieved on these ropes on which quite a number of twists have been removed.

It is hoped that with the improvements now on hand to control the speed of swivelling still better results can be expected.[1]

Acknowledgments.

(1) The author would like to take this opportunity to acknowledge the co-operation and advice received from all his colleagues past and present during the development of the controlled swivel and in addition that of the chief electrical engineer, who designed the electrical improvements for speed control that are being incorporated in the equipment. He is also grateful to the superintendent, Champion Reef mine, for his encouragement and guidance in the preparation of this paper and permission for its presentation.

(2) " Deep Winding on Kolar Gold Fields," by J. W. P. CHALMERS and A. H. P. FITZPATRICK (Paper No. 7 in the " Wire Ropes in Mines " Symposium, Institution of Mining and Metallurgy, 1950.

(3) Correspondence with Messrs. John Taylor and Sons and Messrs. Rooper and Chalmers' Reports.

(4) British Manufacturers' opinions.

(To be concluded)

[1] This article was first read as a paper to the Kolar Gold Field Mining and Metallurgical Society in June, 1960.

Rapid Sinking at a British Colliery

An account of recent work in the Castleford area of the National Coal Board

At Kellingley, in the Castleford area of the N.C.B.'s North-Eastern Division, a new colliery is being opened, which, when in full production, will be capable of producing at the rate of 6,000 tons a day and provide employment for about 3,000 men. Coal is to be worked in an area about four miles square around the village of Kellingley, the area being crossed by the River Aire in the north and the Wakefield–Pontefract main railway line and the Aire–Calder canal in the south. The reserves of coal to be worked amount to 200,000,000 tons, sufficient to give the new colliery a life of about 130 years.

Two shafts, both 24 ft. in diameter, are now being sunk to a depth of approximately 850 yd. and for the first 50 years the output will be extracted from the Silkstone and Beeston seams, which lie at depths of 2,087 ft. and 2,298 ft., respectively. Boreholes proved the existence of 600 ft. of water-bearing Permian measures to overlie the Coal Measures, the upper limestone being particularly heavily watered.

The use of brine freezing for water control, together with a non-simultaneous method of sinking and shaft lining, entailing a high rate of pouring and an extremely consistent mix are amongst the major features of this high-speed shaft sinking which is being carried out by the Thyssen Shaft Sinking Co., Ltd., of London and Llanelly. The freezing process used to seal the shafts against inflows from the strata was carried out by the Foraky Co., Ltd., 37 bores and one centre being employed to each shaft. Of these only two holes became sealed during sinking.

Notwithstanding the limitations imposed by the freezing process, high sinking rates were maintained during passage through the frozen ground and, when clear of this handi-

cap, a new record for shaft sinking was established in the unfrozen ground in January last, when 336 ft. were sunk and 345 ft. lined in No. 2 shaft. This success particularly reflected the detailed organization of the contractors, their close co-operation with N.C.B. officials and their use of high-capacity plant, particularly the batching plant, which guaranteed the maximum availability of large volumes of concrete having an extremely close consistency.

The main sinking of No. 1 shaft started on February 26, and No. 2 shaft on June 19, 1960. Each shaft is served by two tower-mounted friction winders and these are being used for the sinking operation. After shaft sinking has been completed the winders will be fitted with closed loop-control, an electrical device to enable winders to be operated by remote control from the banksman's level. It is proposed to wind the output at No. 2 (upcast) shaft in 15-ton capacity skips ; No. 1 (downcast) shaft wil be equipped with two three-deck cages and be used for winding men, materials, and dirt.

The freezing principle employed at Kellingley consisted of maintaining a continuous sheath of frozen strata around the shafts during sinking, this being effected by circulating cooled brine through tubed boreholes which extend well into the non-permeable strata to ensure complete sealing of the shaft. The verticality of the bores is carefully controlled so that they do not intersect the shaft line and in order that each has approximately the same cooling area surrounding each tube. The freezing tubes, which have screwed connexions, are lowered as soon as a hole is completed, the first tube being plugged at its base. As successive joints are made, they are pressure tested for tightness, a small-diameter tube being then inserted into the completed column. After a final pressure test, connexion is made with the brine mains, the refrigerant flowing down the small-bore tube and up through the column to the mains on the refrigeration plant.

The refrigerant is a solution of calcium chloride in water, the freezing point of which is — 22° F. at a specific gravity of 1·24. The surface brine mains are 8-in. bore and are lagged with a 2½-in. thick layer of insulating cork. At the refrigeration plant liquid ammonia is evaporated at low pressure in tubular heat exchangers, the latent heat of evaporation being derived from the brine during its passage through the heat-exchanger tubes. The ammonia gas is taken from the heat exchangers to high-speed single-stage vee-type ammonia compressors, these being six-cylinder machines driven by 150-h.p. A.E.I. slip-ring induction motors. They deliver to banks of condensers which are cylindrical heat exchangers upon which cooling water is played, resulting in liquifaction of the ammonia before passing out through automatic expansion valves and to the brine heat exchangers. Each ammonia circuit is independent, the four circuits being used to give the maximum reliability in maintaining brine circulation. Some 1,200 lb. of ammonia is used in each circuit, while the brine circulation is some 70,000 g.p.h., maintained by two pumps, the brine containing some 70 tons of calcium chloride.

The circulation of the brine through the entire system results in long columns of frozen ground being produced round each freezing tube, the diameter of the columns increasing as freezing continues until they merge with one another and an ice wall is formed. As the ice forms water is displaced and, when the ice wall is completed, careful measurements of the quantity and temperature of the water expelled through the pilot hole gives a useful indication of the extent to which the freezing process has progressed. Whilst sinking of the shaft is in progress the refrigeration rate is maintained in excess of the melting rate due to the higher temperature of the surrounding rocks, the ice wall gradually thickening until it extends for some distance beyond the excavation and the unfrozen core has become completely frozen, thus forming one solid cylinder of frozen rock in which the shaft is sunk. When this is achieved, any faulty bore can be isolated from the mains without affecting the progress of the work.

Rotary drilling for the freezing bores began at the end of March, 1958, and was completed in early September, 1958, a total of some 49,450 ft. being drilled. With the boring completed, and the refrigeration plant installed, freezing at the site of No. 1 shaft was started on October 27, 1958, the ice wall being closed at the end of February, 1959. Commencing and closing dates for No. 2 shaft were December 15, 1958, and July 9, 1959, respectively, the resulting ice walls formed being some 80 ft. in diameter.

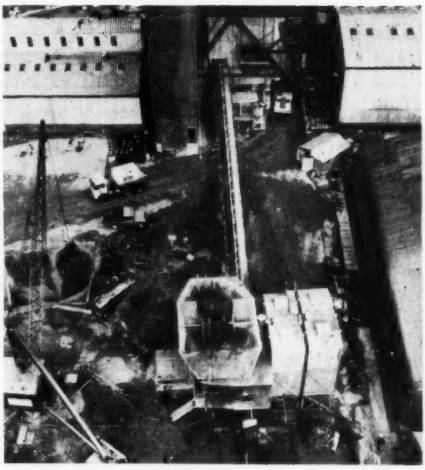
Sinking through frozen ground entails a number of particular considerations ; of these, the first is concerned with limiting the amount of charge and determining the most suitable pattern to obviate damage to the

freezing tubes by excessive shock waves. Drill penetration rates are usually much lower and a fairly high number of holes may be rejected. In particular, difficulties are experienced with ice fissures extending for many feet which cause the steels to become frozen into the ground.

With regard to shaft lining problems encountered here, these include those due to the effect of the heat of hydration on the ice wall and its expansion. The need to ensure a high degree of consistency in the mix and the minimum amount of segregation during pouring is of the greatest importance. At Kellingley the former condition was met by the use of a Blaw-Knox " AP 100 Gyramixer " with delivery of the concrete *via* a conveyor to a roller gate hoppit and then to an octopus situated between the decks of the shaft stage. A further feature of note is the accommodation required to be made to allow for the effects of surface lift. This feature, resulting from the expansion caused by the formation of ice and variation of temperatures, is sufficient to throw the permanent winding towers out of alignment. To enable corrections to be made the tower bases are mounted on grillages with facilities for jacking in order to keep the towers level. Account had also to be taken of the need for providing effective support for the weight of the shaft lining while sinking through frozen ground since corrugated sheets prevent the concrete from adhering to the ground.

The majority of lining in the frozen ground is of 18-in. thickness, but towards the base of this frozen area, at 460 ft., the thickness of the lining was increased in steps from 18 in. to 24 in., then to 27 in., at which point the frozen ground ended. Below this level the lining was reduced in thickness from 27 in. to 24 in., then to 18 in. and, finally, to the normal ground lining of 12 in.

The main equipment used for the sinking consists of a two-deck stage which is suspended in the shaft by four ropes which also act as guide ropes for the riders of the hoppits. The decks are 30 ft. apart and surmounted by a catwalk 10 ft. above the top deck. The first or upper deck carries four 2-ton worm-driven self-stabilizing winches for movement of the shuttering in the shaft. The air and water manifolds are also carried on this deck. Between the decks the octopus and chutes for emplacing the concrete lining are located, the chute trunking being of light-gauge steel sections joined by chains to give flexibility in operation. Two columns for air and water



Batching Plant Serving Both Shafts.

services are also fixed between decks, the top manifolds receiving hoses from pipelines temporarily attached to the shaft lining.

Underneath the bottom deck of the sinking stage the mechanical loading equipment is situated. This is compressed-air driven and is suspended from an inner and outer monorail. The main hoist motor which operates the 20-cu. ft. Priestman cactus grab, is also mounted on rails inside the unit, which then allows the grab transverse as well as circumferential movement. The 20-cu. ft. grab is of the compressed-air six-bladed type.

The circular monorail is broken for a short section to allow the stage to be raised above the level of the services pipes fixed to the shaft wall and, at the point where it is broken, an inner rail on a shorter radius is provided to maintain continuity. The drilling hoppit consists essentially of a number of radial steel-sheet plates, which form segments to which the drilling machines are returned after use. Each machine is numbered and a corresponding number is marked on each segment of the hoppit. Thus any defect in the drilling machine is noted on the plate forming the segment corresponding to the drill and is easily read off by the fitter on surface. The mucking hoppits (No. 1 shaft, 85 cu. ft. and No. 2 shaft, 105 cu. ft. capacity) are secured to the winding rope by three suspension chains, the chains being detachable from the hoppits to leave them clear for loading.

The winders are part of the permanent mine installation. At No. 1 shaft a friction

winder is driven by a 1,100-b.h.p. A.E.I. motor, while at No. 2 shaft the winders are driven by twin 1,100-b.h.p. A.E.I. motors, at 11,000 V. The winder drums were modified during sinking to accommodate single-rope winding. The towers are of steel construction and are fitted with deflection pulleys in order to bring the winding ropes into the correct position for sinking.

The prime requirement of a fast high rate of production coupled with a consistent mix of constant water to cement ratio has been met by the provision of the Blaw Knox AP. 100 concrete mixing plant which has an output of 100 cu. yd. per hour and can feed to either shaft. Essentially this consists of four sections, the first of which is an eight-compartment batching plant which has an aggregate storage capacity of 100 cu. yd., a weighing unit, and a control panel; cement is stored in expendible bulk cement handling units. The main section comprises the twin "Gyramixers," which have a mixed batch output of 28 cu. ft. A further section consists of two specially fabricated conveyors, constructed by the Thyssen Shaft Sinking Company, which take the concrete to either shaft and the 2-cu. yd. wet-receiving hopper located there to receive the concrete before discharge to the 2-cu. yd. roller skips used for transport down the shaft.

The batching plant comprises three main units, these being the main bin unit which includes the operating platform and control panel, the supporting structure and aggregate weigher, and a flared-top section. The operation of the plant, through the control panel is by air-assisted manual controls and weigh dials. Pneumatic rams control the radial gates feeding aggregate to the weigher, an air-operated valve controlling the discharge of cement to an independent weigher. Water is metered out in a 35-gal. siphon-type pressure tank calibrated in pounds and gallons and is discharged to the mix by a press-button control. The containers operate at a pressure of 90 p.s.i., the supply being derived from the town mains supply. In addition to the hand-operated valves for operating the main discharge rams, the control panel is also fitted with indicator lights which show such points as the position of the mixer door, the length of the mixing period, and whether electric power is on for control operations.

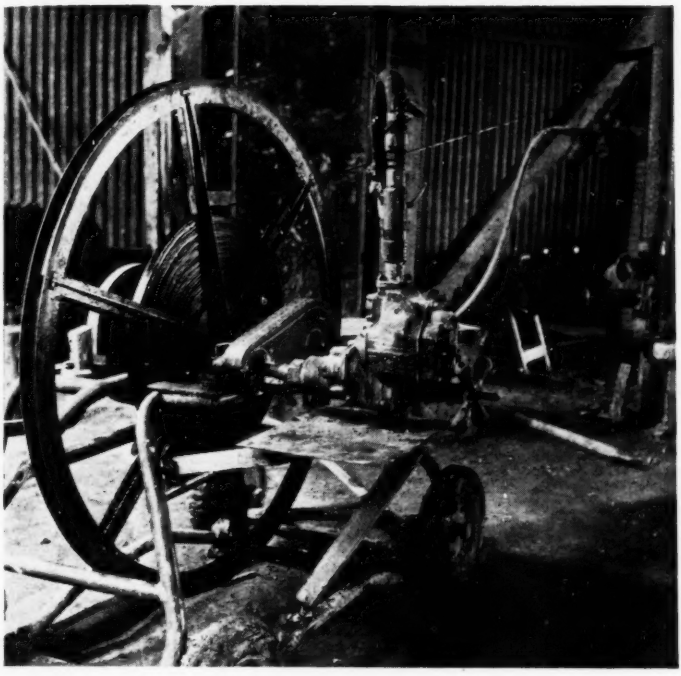
The two Gyramixer stationary pan-type units incorporated in this plant each have an unmixed capacity of 42 cu. ft. and a mixed batch output of 28 cu. ft. The overhead drive to each is a single enclosed unit and the pan, fabricated from wear-resistant alloy steel, forms an integral part of the base structure, which allows shallow mixing and eliminates the need for a central pedestal. Discharge is through a 13½-sq. ft. rectangular sliding door, the movement of which is ram controlled. The mixing unit consists of a rotary gearbox which revolves about its own axis and is fitted with three mixing blades. Floor and wall scraping blades are also attached to the rotating gearbox. The stars rotate at unequal radii and the blade path is such that the entire pan area is covered once in each revolution. With these mixers batch time throughout the contract was 30 seconds.

The specifications require a minimum strength of 4,500 lb. per sq. in. at 28 days in frozen ground, the average figures obtained to date being 7,000 lb. per sq. in. In unfrozen ground the specification is for 3,000 lb. per sq. in., the average figure reached here being 6,000 lb. per sq. in. at 28 days. During the lining in frozen ground "Sulfacrete" was employed, Earles Portland cement being used in unfrozen ground.

The aggregates are closely checked for organic content, moisture sizes, etc., and the aggregate pits are heated with steam pipes to maintain an even temperature and hence control the moisture content. The container on the batching plant is also heated, this guaranteeing uniformity of mix and moisture content. The mix used in the frozen section was 0·296 tons cement, 0·429 tons sand, 0·729 tons gravel, 12 gal. water. In the unfrozen ground the mix was 0·239 tons cement, 0·594 tons sand, 0·880 tons gravel, and 18 gal. water.

The sinking routine in frozen ground was dominated by the necessity of ensuring that the freezing tubes were not damaged by excessive shock waves. Thus, in this section, a 3-ft. square draw cut, comprising 12 holes, followed by a round of 64 holes was adopted and, in order to rationalize the drilling as far as possible, the floor of the shaft was divided up into quadrants and the cut, two machine men being permanently allocated a section. Thus, in the cut, the two most experienced drillers were located, each drilling the full depth of 6 ft. and working on diametrically-opposed holes. In the quadrants the first of the two drillers worked to a depth of 4 ft. 6 in., continuously, the second machine man being permanently engaged in deepening these holes to 6 ft.

Ice-filled fissures of up to 30 ft. in depth and



Control Gear for the Survey Tape.

6 in. wide caused considerable difficulty when drilling throughout the frozen ground. The frictional heat generated by the rotating bit causing a rapid thaw of the ice, which in liquid form was blown up the hole, refreezing in the process. Thus large numbers of holes were rendered useless by the drill steels becoming completely frozen in their holes. Modification of the drilling machines to allow for high-volume blowing of compressed air at the tip, in order to cool the bit and remove from the hole any liquid formed before refreezing took place, met with some success. Integral drill steels with cross bits were used throughout the frozen ground, but did not prove ideal for normal ground. There integral steels with chisel bits produced far better results.

Charging of the boreholes is carried out by N.C.B. deputies assisted by Thyssen personnel. The amount of explosive to be used in any one round in the frozen area was limited to 150 lb. to ensure that excessive shock waves were not set up, the depth of the rounds varying between 6 ft. and 10 ft., according to the strata encountered.

This limitation of explosives made it necessary to fire twice for each full round of holes bored, the outer or cropper holes being fired separately from the rest of the round. Parallel mains electrical firing was employed. To reduce charging time to a minimum the bus bars are prepared on surface in a priming shed. The bars are laid out in accordance with plans displayed on a wall panel which show the exact positions for attaching the detonator leads. These leads terminate in "inert" primers which consist of plaster of paris containing an outer groove for the detonator leads, the detonator being inserted firmly through the centre of the plaster of paris such that it protrudes approximately $\frac{1}{4}$ in. into the following stick of explosive. Non-inflammable sand-filled paper bags are used for stemming.

Smoke clearance is effected by a booster fan in the main 30-in. air services column which is carried down as shaft lining proceeds. The stage is raised 150 ft. before firing and the shaft is inspected before it is lowered after firing. With the stage in position, mucking commences, using four hoppits. Thus, while the grab fills a hoppit on the east side of the shaft, the west winding rope drops an empty hoppit on the west side of the shaft and picks up a full one. When the hoppit on the east

side is full the grab swings around and commences loading on the west side. Loading is always arranged to take place underneath the winding rope carrying the full hoppit to the surface.

The temporary support employed in frozen ground consists of steel channel rings, suspended on hooks, with dowels inserted in the ground every fifth ring to provide additional security. Behind the steel rings are placed corrugated sheets held against the ground by timber poling boards and wedges. Sinking and lining routine in Coal Measure strata was to sink 40 ft. and to line this section immediately. During sinking the ground was secured by wire mesh and anchor bolts which were placed at a minimum depth of 4 ft. into the rock. This system could not be worked in the frozen ground due to the presence of the corrugated back sheets which prevented the concrete adhering to the ground. The following procedure was therefore adopted:—

(1) 40 ft. of shaft was sunk and back sheets placed only in the top 30 ft.

(2) A concrete crib was placed in this bottom 10-ft. section which was in immediate contact with the ground.

(3) Sufficient waiting time was allowed to elapse before sinking further to allow this crib to gain strength. Only in the first crib placed in either shaft was this waiting time required.

(4) A further 40 ft. of shaft was again sunk and again only the top 30 ft. back sheeted.

(5) Another crib was placed in this bottom 10 ft.

(6) As soon as this crib was placed lining of the first 30 ft. (Item 1) took place.

This procedure was followed throughout the frozen ground and allowed each crib sufficient time to gain strength to support the 30 ft. section above it.

The lining was emplaced in 5-ft. lifts, the shuttering consisting of two 2-ft. 6-in. high rings of $\frac{1}{4}$-in. steel plate, used with releasing segments. In frozen ground provision was made in every 5-ft. lift for eight injection pipes, with a further eight being located in the crib ring. The grouting was carried out within 10 days of placing any part of the lining, while local thawing of the ice was occurring.

For each 40-ft. section some 20 tons to 30 tons of cement were injected, using a Boulder grouter. The grouting was carried out at a maximum pressure of 60 p.s.i. The mix was prepared on surface in a tub fabricated from a section of ventilating tube, in which rotating paddles are located, these being powered by a Consolidated Pneumatic type 327 drill. From the mixers the grout passed by a 2-in. plain flanged cavity line down the shaft, this terminating in a rubber hose which connected with the Boulder grouter situated on the sinking stage. A $\frac{3}{4}$-in. air line was taken from the stage manifold to the grouter, which has a pressure-reducing system. The grouter, which incorporates its own agitating chamber uses some 80 c.f.m., and has a chamber capacity of 4 cu. ft. The high degree of agitation provided by the grouter was particularly important during the operations in ensuring the injection of a high-quality grout.

The concrete is brought down the shaft in Blaw Knox 2-cu. yd. concrete skips; these discharge to a folding chute from the base of which is led four trunk ranges, thus splitting the concrete equally into four parts. Each section of the light-steel trunking is cone-shaped and has hooks at its base to allow other sections to be attached by chains, this arrangement also giving the maximum flexibility and ensuring that concrete is placed without segregation taking place. Of particular importance is the achievement of a thorough vibration to eliminate voids and ensure uniform compaction. This is carried out with Consolidated Pneumatic 325 poker vibrators. During the placing of the lining provision is made for pipe clamp supports, safety rope support, and also bunton boxes for cross girders for guide rails.

Holes to accommodate steel pins for the stage safety ropes are placed every 40 ft. and attached to these pins are pulleys to facilitate movement of shuttering in the shaft. The ropes from the four winches on the top deck are passed around these pulleys and then attached to the shuttering at four points. Four safety ropes are attached to the stage during mucking operations to prevent overload on the guide ropes. Temporary supports are used in the Coal Measure strata of B.R.C. 13-gauge wire mesh, 3-in. by 3-in. squares in sheets of 6 ft. by 14 ft. and 4-ft roof bolts with Rawlshields and 9-in. by 7-in. by $\frac{3}{8}$-in. steel plates. Where ground conditions were normal roof bolts were placed in rows, 5 ft. between each row to allow 1 ft. overlap on the wire-mesh sheets. If the ground conditions deteriorated double sheets of wire mesh were placed and extra roof bolts were inserted where necessary. Occasionally it was found possible to recover a small percen-

tage of the roof bolts during concreting operations, but this depended entirely on ground conditions.

A lazy-chain method of muck tipping is employed at surface, the tipping level being fitted with interlocked pneumatically-controlled doors such that the muck chute loading the storage bins from the hoppit cannot be lowered without the bottom shaft doors being first closed. The lazy chain which lifts the bottom of the hoppit is also arranged so that it cannot be applied unless the muck chute has first been lowered.

Each week 20 shifts are worked, the N.C.B. taking over the shafts on Sunday dayshift each week for maintainance and testing of their equipment. Each shift is of eight hours, with a 30-min. break for food. Underground each shift consists of 1 foreman, 1 chargehand, 1 grab driver, 2 onsetters, and 8 sinkers. The output from No. 2 shaft during the record-breaking month was some 15,000 tons of rock excavated and 2,880 tons of concrete emplaced.

The establishment of new high-sinking rates at this site by the contractors reflects to a considerable degree the detailed attention given to all aspects of the sinking routine. This is particularly reflected in the attention given to such points as the provision of drill hoppits and the use made of small portable air motors to provide power for such operations as grout mixing, tape winding, etc. These motors are actually Consolidated Pneumatic type 327 reversible drills which are welded to suitable frames and which, in the case of tape winding, provide an extremely convenient method of raising and lowering the shaft measuring tape without damage.

Progress at Grangesberg

J. Grindrod

Developments at mines in Sweden and Liberia and progress at new steelworks are reviewed

As well as developing its mining interests at the Grängesberg and Stråssa mines in Sweden and at the Liberian Nimba mine, which it is managing for the Lamco Group, Grängesbergsbolaget, on June 17 last inaugurated Sweden's newest integrated steelworks, claimed to be the only one in that country designed for the output of a single product—*viz.*, high-grade heavy plate. During 1960 the total ore production from the company's Swedish mines was 2,240,000 metric tons, the Grängesberg mine contributing 1,870,000 metric tons, of which about three-quarters was lump ore and the remainder fines and a small amount of A10 concentrate. The newly-opened Stråssa mine yielded 370,000 metric tons of concentrates. Deliveries amounted to 2,170,000 metric tons compared with 1,620,000 metric tons in 1959. Of the total ore deliveries 1,720,000 metric tons was exported, business conditions continuing firm in Western Europe and the demand for ore being considerably greater than in 1959.

At Grängesberg itself the total weight of rock extracted in 1960 was 2,800,000 metric tons, to which sub-level caving and block caving contributed approximately equal shares. Shrinkage stoping was also employed on a small scale. With the object of raising its capacity, rationalizing its operation, and improving the extraction of good homogeneous lump ore, the dressing plant is being rebuilt and is expected to be completed in the autumn of 1962. The recovery of ore from non-magnetic stock over 50 mm. in size was previously carried out by hand picking, but, during recent years, the ore is now treated in a sink-float plant consisting of three units.

Rebuilding work and the installation of a new leaching process in the A10 concentrate plant has also been carried out. Leaching with nitric acid, a method thought to be exclusive to Grängesberg, yields a concentrate virtually free from phosphorus and sulphur and containing 71·4% iron. This concentrate is used, among other things, for making sponge iron. A start has also been made on assembling a small plant for the

View of the Oxelösund Steelworks.

recovery of the resulting by-products in the form of nitrogenous and phosphoric fertilizer. An experimental plant for the flotation of tailings with the object of producing apatite concentrates was also installed during 1959 and has since been in operation.

At the Stråssa mine, which has been operating as a regenerated mine since 1959, 960,000 metric tons of rock were extracted in 1960. Most of this was taken from the 80 m.- and 135 m.-levels by slice stoping, but 15% came from opencast workings. Consolidation of operations and development and preparatory work are being continued. Of the low-phosphorus concentrate produced 40% was reserved for the needs of the company's Iron and Steel Division and the rest exported. A pelletizing plant dimensioned for 200,000 metric tons of pellets a year is under construction to start producing in 1963.

At the Oxelösund Iron and Steel Works existing plants are producing 143,000 metric tons of pig-iron and 33,000 metric tons of sponge iron a year and have been augmented by an important new integrated steelworks, capable of producing 300,000 metric tons per annum of heavy plate. The plate rolling mill has been in operation since April, 1960; an open-hearth furnace since July, a slabbing mill since November, and, during the same year, a new by-product plant for the recovery of coal tar, benzene, and toluene and for the production of ammonium sulphate was brought into operation. A new sintering plant and a new section of the coking plant were started up in March, 1961, and a new blast-furnace and two new Kaldo furnaces for steel production more recently inaugurated. Other additions scheduled for 1961 are kilns for limestone and dolomite. When in full operation the new and old steelworks will consume about 800,000 metric tons of ore, 450,000 tons of imported coal, 150,000 tons of limestone from quarries on the island of Gotland, 40,000 tons of dolomite, and 60,000 tons of oil.

To take charge of the large-scale activities in Sweden and Liberia, which the task of managing the Liberia project entails, Grängesberg has set up a new division, these operations being directed from Stockholm, where the planning work is also carried out. Most of the organization's personnel, however, serve in Liberia, either at the head office at Nimba or at smaller offices at the port of Buchanan or the capital Monrovia. The first mapping of the Nimba Massif was made at Christmas, 1955, and the project is scheduled to be ready for operation by the early summer of 1963, with an annual capacity of 6,000,000 metric tons of ore. A quarter share in the concession is now owned by the U.S. Bethlehem Steel Corporation and the rest by Lamco, which is half owned by the State of Liberia and half-owned by a Canadian company, the Liberian Iron Ore, Ltd., a consortium of Swedish-American companies.

The main deposit within the areas covered by the concession is at Mount Nimba and the orebody surveyed contain at least

235,000,000 metric tons of high-grade iron, with an average content of 66% iron and 0·03% phosphorus. Mining will be done by open-cast methods.

During 1960, Grängesberg, on behalf of Lamco, entered into a contract with a group of West German steel producers covering the delivery of 2,500,000 metric tons of Nimba ore per annum for 17 years from the start of production, the buyers being entitled to extend the contract. A five-year contract covering 500,000 metric tons of ore per year has also been concluded with a French group. Through the participation of Bethlehem Steel and on the strength of these contracts it was possible to complete the financing of the Nimba project in the course of 1960.

Of Lamco's share in the financing the Swedish participants are to provide a total of about $50,000,000, while most of the rest has been borrowed on the international money market: $50,000,000 from the Kreditanstalt für Wiederaufbau, in Frankfurt, $30,000,000 from the Export–Import Bank, in Washington, and $5,700,000 from the First National City Bank of New York.

Concurrently with development work at the mine large sections of the haulage roads and residential areas have been completed. A start has been made on the construction of the road-bed for the 270-km. railway and on the outer breakwater for the Buchanan ore harbour, the main contract for the railway and harbour installations having been placed with the American firm Raymond International (Liberia) Inc.

The ore will be mined by benching in open-cast working and rotary drilling machines will probably be used. Much of the ore is so loose that it can be loaded straight away with an excavator, but to enable full use to be made of the load capacity of the buckets, the ore will nevertheless to a large extent be blasted first. Diesel-powered 25 to 35 ton ore trucks will move the ore to the crushing station, which will be built at an altitude of 1,170 m. Thence it will be carried by a 3 km. long conveyor belt down to the railway terminus. A maximum trainweight of 7,500 metric tons is envisaged and the rolling stock will consist of diesel locomotives, the first 10 of 2,000 h.p. each having been ordered, and some 400 ore cars with a loaded capacity of 90 tons. The movement of trains will be centrally controlled by the Swedish CTC system.

At Buchanan, the ore will be either dumped in a 1,300,000 metric ton capacity storage area or loaded straight to ships. The ore-loading facilities are being dimensioned to deal with up to 6,000 metric tons an hour. The harbour will initially take up to 45,000 ton d.w. ore boats, later possibly boats of up to 60,000 tons d.w.

At the end of 1960 Grängesberg personnel in Liberia numbered about 1,740, comprising 1,620 Liberians, 70 Swedes, and 50 other nationalities.

Ore-Dressing Notes

(10) *Roasting*

A Refractory Gold Ore (1)

A recent paper by R. J. C. Tait [1] describes the research and practical follow-up which led to improved recovery from Giant Yellowknife (Canada) gold ore, which carries pyrite, arsenopyrite, stibnite, sphalerite, pyrrhotite, chalcopyrite, and galena, the antimony minerals including berthierite, jamesonite, and tetrahedrite. Most of the gold is believed to occur sub-microscopically or in solid solution in the arsenopyrite. The host rocks are sericite, sericite-chlorite, and chlorite schist in pre-Cambrian greenstones. Most of the schists slime readily and present difficulties, since flotation is concerned to produce a relatively slime-free float suitable for fluidized-bed roasting.

In roasting to produce a good porous structure optimum temperature for elimination of arsenic requires strict control of temperature and of oxygen availability in the furnace atmosphere. After this further roasting is less critical as regards temperature in the usual way, but with stibnite present extraction is badly interfered with unless the temperature is controlled right through this stage of the work. At 900° F. extraction of gold from the calcine exceeds 90%, even with 2% Sb present. During oxidation the temperature must not rise above this until the charge is visibly dead-roasted. Exploratory work, using a small muffle furnace, showed that arsenic must be eliminated at below 925° F., with limitation of oxygen supply, after which further oxidation must proceed with continued control of temperature at 900° F. These findings were in due course successfully transferred to plant scale in a two-stage fluid-bed roaster.

[1] *Canad. Min. Metall. Bull.*, Apr., 1961.

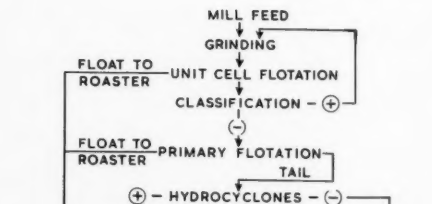


Fig. 1.

Continued use of the Edwards-type of roaster was ruled out because of its low productivity (40 tons of concentrate daily to 3,800 sq. ft. of hearth area). With less than 1% of antimony in the concentrates the Edwards metallurgy was as good as that achieved by fluid-bed work, but with more refractory material the latter treatment was better, despite defects in the original design and high dust losses, which were in due course overcome. The original FluoSolids roaster was a single reactor with two compartments, each separately supplied with air. The intention was that partly-roasted calcine should flow smoothly through three small transfer ports in the dividing wall to the second (dead-roasting) stage. These transfer ports were inaccessible and when blocked could not, therefore, be cleared. Also the tail pipes from the first stage cyclones, which delivered into the bed of the second stage, were difficult to get at and to clear when plugged.

These defects were partly solved by enlarging the transfer ports and shortening the tail pipes, but there were other difficulties. The segmental shapes of compartments divided by a vertical wall in a cylindrical roaster led to dead spots starting at corners and checking fluidity till the transfer ports were affected. The enlarged ports, too, permitted diffusion of oxygen and loss of atmospheric control. It was decided to build a new two-stage roaster designed to overcome these troubles, which were outweighed by such advantages as compact design, relative cheapness, good operating control, and a better understanding of what must be built into the new plant. This was designed to handle 1,000 tons of flotation concentrates daily, as soon as it could be erected. Increase in flotation circuit and cyanidation capacity were expanded in line with this programme.

The original grinding circuit produced a mill discharge of up to 900 tons daily at 77% *minus* 200 mesh, with the values largely in the fine sizes of the ensuing flotation concentrates which sized at 70% *minus* 200 mesh; 24% of the gold occurred in the *minus* 10μ fraction. This led inevitably to high dusting losses and to flash roasting and fusion of much of this fine material. A modified grinding circuit (1958) brought down the mill discharge overgrind, the flotation concentrates then showing only 55% *minus* 200 mesh, with improved recovery and cyanide extraction. With the advent of the new roaster the flow-sheet received further modification, an important feature being the use of unit flotation cells between the secondary ball-mills and the classifiers, delivering their float direct to the roaster. By mid-July, 1959, concentrates containing 54½% *minus* 325 mesh material which carried 70·7% of the gold were being produced and dusting losses were appreciably reduced.

The most recent flow-sheet (not yet fully settled) is shown in Fig. 1, adapted from the author's Fig. 7. It includes desliming of flotation concentrates in cyclones and separate flotation of the sands and slimes thus separated, the former receiving a light regrind. Flotation rate has thus increased and recovery improved without apparent gold loss in the roaster dust. Before this desliming and extra grinding some 85% of the gold has been recovered *via* the unit cells and primary flotation circuit. Recovery in the flotation circuits has also improved despite increased milling rate without expansion of cell volume. Roasting operations have improved—a fact attributed to better grinding and flotation techniques and elimination of slimes.

(11) *Solvation*

Sulphur Extraction

Laboratory-scale testing, currently reported in *World Mining* (July, 1961) by F. D. Huillet

and C. J. Lewis has brought within economic probability a new technique for recovery of sulphur from low-grade deposits. This is due to the availability of dimethyl disulphide (DMDS), a chemical with a boiling point of 109° C., moderate inflammability, and the ability to produce a 73% solution of sulphur at 90° C. It might, in the opinion of the reporting authors, deal with deposits unsuited to the Frasch process, which are known to exceed 200,000,000 tons of elemental sulphur. In Italy kilning and regenerating furnaces use part of the sulphur as a fuel to liquefy or vaporize the remainder, giving a recovery of some 65% of moderately pure sulphur. Other methods use autoclaves and froth flotation for low recovery at rather high cost. Solvent extraction based on the use of carbon disulphide and hydrocarbons raise process difficulties associated with high-vapour pressure, fire risk, and toxicity.

In tests on Sicilian ores crushed to *minus* 10 mesh leaching was found to be 99% efficient at temperatures between 85° C. and 90° C. with DMDS, falling to 91% with coarser crushing (to *minus* $\frac{1}{4}$ in.). The solvent loss per ton of crystallized sulphur produced was below 20 lb. of solvent when treating high-grade ores. These octahedral crystals, produced by slow cooling of the pregnant solution, assayed 99·9 + % S and were 90% *plus* 28 mesh.

An advantage of this leach method is that it is easily made continuous. The inflammability risk appears comparable with that of kerosene. The higher reagent cost, as compared with carbon disulphide, seems cancelled out in process costs. Extraction from high-grade flotation concentrates was found very effective and might be made part of the treatment. Non-aqueous pregnant solution (sulphur in DMDS) was found corrosive to brass and copper but very low to carbon steel.

(12) *Pumping Slurry*

Some General Considerations

Hydraulic transport has to-day reached the point where it should be considered on its own merits as a means of moving powdered or granular material and a recent paper by Condolios, Couratin, and Pariset [1] considers in some detail the possibilities of industrial application. Capital installations are usually favourable where roads, rail, etc., do not yet exist, while operating costs for fine material are low provided there is no severe abrasion problem, although for lump material they are less likely to be competitive.

In experimental work the authors noted three types of particle behaviour in transport by liquids. At *minus* 0·2 mm. diameter they were carried in suspension; above 2·0 mm. they moved by saltation; between these sizes the type of movement depended on the flow velocity. For horizontal transport the energy input per unit of weight transported must be suited to the mass and size of the particles. It decreases with increased loading and up to 2 mm. is very sensitive to change of size, falling to a minimum when transporting fine material in plastic flow. Taking the case of pipeline transport at the rate of 100 tons per hour of material uniform in density gravel exceeding 2 mm. would require about 6 h.p. per ton mile; sand averaging 0·4 mm. some 2·2 h.p., and raw cement paste at 40μ–50μ only 0·12 h.p. Vertical transport problems are much simpler than those which include the effect of settlement en route, the important requirement being a transport velocity of twice the settling rate of the particles in free fall.

Transport interruption is due to two causes—jamming and flow instability. The conduit must be of at least three times the diameter of the largest particles, unless these are infrequent, when twice the diameter may suffice. If there is a pump in the flow-line the maximum particle diameter must not exceed half the smallest pumping cross-section. If the delivery rises steeply means of emptying out the load must be provided which can operate swiftly in case of a sudden shut-down. With some installations water hammer must be provided against.

The main maintenance costs arise from wear of pumps and pipelines and vary from below 0·03 cents per ton-mile for cement paste to over 4 cents for gravel; labour cost is small. Overall cost per ton-mile for finely-ground and relatively non-abrasive material can be below 0·3 cents; for sands they compare with standard costs for solid transport, but for larger material they rise toward 30 cents. Figures quoted in the paper show costs for some operations. In one plant handling very abrasive ore up to 0·5 mm. in diameter at a rate of 25 tons per hour, the upkeep, power, and labour for the past year have totalled 2·5 cents per ton.

[1] *Engg. J.* (Canada), June, 1961.

Letter to the Editor

The Perimeter Blast

Sir,—I read with interest Mr. Hugh G. Jarman's " Note on the Perimeter Blast " in your August issue, but I wondered whether Mr. Jarman, the Canadian firm for whom he is writing, A. D. Margison and Associates, Ltd., and their mining consultant, Mr. P. S. Broadhurst, had studied the literature of their subject with due thoroughness. If they will consult the *Transactions* of the Institution of Mining and Metallurgy, Vol. LV, 1945–46, they will find a paper by myself entitled " Tunnelling in Gibraltar during the 1939–45 War." This describes the work of British and Canadian Army Tunnelling Companies during the war and gives details of long-hole blasting methods similar to those described by Mr. Jarman, but a good deal more advanced. There, in a single instantaneous " perimeter blast " (to use Mr. Jarman's expression), 10 ft. of the back was brought down over an arched chamber 50 ft. wide, and for a length of 261 ft., a perfect, gentle blast of 10,000 tons. In my paper it was stated—" The logic of the diamond drilling technique will become apparent as this account proceeds, but it should be observed that the most excellent feature of the method as finally developed is that it produces an excavation with sides and back in an extraordinarily smooth and safe condition." The caption to Plate IX remarks—" The diamond-drill holes in the back are clearly distinguishable, as also is the clean fracture."

We were, I think, the first users of " long " cartridges. These were 2 ft. 6 in. long and in two diameters—1⅛ in., weighing 10 oz. per ft., and 1¼ in., weighing 12 oz. per ft. They were ordered early in 1944 at my request by Brig. G. W. R. Nutt, then Chief Engineer, Gibraltar, and were specially (and beautifully) made, to the best of my recollection by Imperial Chemical Industries, Ltd. Trouble had been experienced in loading long blast-holes with conventional short cartridges, culminating in an accident (the trouble with nitro-glycerine explosives is, alas, nitro-glycerine) and this prompted the decision to try out long cartridges, which were completely satisfactory. This early use of long cartridges may have been overlooked also by our Scandinavian friends.

While writing on this topic I should like to mention that we were among the earliest users (1944) of the air-leg, actually the Ingersoll-Rand " Jackleg." I have often wondered who was the genius that first thought of the air-leg, for as an important innovator in mining, he is surely worthy of a niche in mining history.

W. H. WILSON.

Indian School of Mines,
Dhanbad,
Bihar,
India.

September 15, 1961.

Engineering Log

Perhaps the most important appliance among those which have revolutionized the work of mineral prospecting is the airborne magnetometer.[1] Concentrations of mineral are nearly always associated with magnetic distortions of the earth's general field and can be detected from thousands of feet above the surface. Conventional geophysical methods which detect local masses of high-density ore, changes in electric conductivity, seismic effects, etc., are of high value, but must be used in contact with the surface of the ground and cannot, therefore, make rapid surveys over vast areas as can an instrument carried in an aeroplane. The generalized magnetic field of the earth resembles a bar magnet one-third of its diameter and canted about 20° from its spin axis. This field varies from 0·7 Oersted at the magnetic poles to 0·25 or so on the magnetic equator. Geo-magnetic measurements are made in units called gammas, which are 0·00001 Oersted. The general pattern of the field is subject to variations due to regional irregularities in the shape and composition of the crustal rocks and upper mantle and also on a lesser scale to disturbances due to concentrations of magnetic material in the mineral deposits of special interest to mining. Broadly, magnetite is the main exciting mineral in these anomalies and can produce up to a 10% change in field strength in a large deposit. The discovery of the Marmora orebody in southern Ontario at a depth of 200 ft. was due to the influence of this 100,000,000-ton magnetite deposit disclosed in aeromagnetic mapping of the district, which showed no surface signs of ore. Since magnetite is widely associated with so many types of ore deposit the modern air-borne magnetometer has been developed to

[1] JENSEN, H. *Scientific Amer.*, June, 1961.

a sensitivity able to detect this association. Sedimentary rocks rarely carry magnetite and the indications of basement rocks, by their relative weakness, indicate the depth of the underlying anomaly.

* * *

Early magnetometers, although both sensitive and accurate, worked by balancing field force with a sliding weight, or by use of the earth inductor, which measured the field set up by the voltage induced in a rotating coil. In these forms the magnetometer could not be used in an aeroplane. In the 1930s the flux gate was developed and stabilized to meet the conditions of aircraft in flight. The original research was directed to submarine detection and, in 1944, was first tested in connexion with geophysical survey. The flux gate is essentially a pair of parallel coils so arranged as to produce a voltage when placed in a magnetic field. Voltage is at its maximum when the axes of the flux gate and the field are parallel and zero when these are at right angles. The device must, therefore, be flown accurately aligned to the earth's field in order to measure the total field, with its local anomalies. To do this three flux gates are mounted with their axes mutually perpendicular on a freely swivelling platform. Two of these maintain themselves perpendicular to the field, leaving the third parallel. The first two are equipped with servomotors and voltage coming from them causes them to turn so as to decrease it till zero output is obtained. The third gate is the measuring element and its sensing coils are surrounded by a solenoid through which a current passes under the control of a servomechanism, so adjusted as to cancel the output from this flux gate. This nulling current therefore measures the earth's field and is sensitive in present-day instruments to as little as a half-gamma. Still more sensitive instruments are now in use, such as the proton-procession magnetometer in which the sensing elements are hydrogen nuclei. The instrument is not usually suspended from the aeroplane, but placed either at the wing tip or just behind the tail. Stray fields in the aircraft must be compensated accurately. The survey is usually flown at right angles to the main trend of geological features at intervals of between a quarter and a full mile. Checks are made by flying cross lines. Air photography correlates the magnetometry with the topography concerned, save where featureless deserts or seas are flown, when special navigation aids are used. The continuous profiles mapped by the instrument are finally plotted as magnetic contour lines. More is spent today on this form of prospecting than on all the geophysical prospecting done before the war, and its use, linked with radiometric surveys, continues to expand.

* * *

Only in Iceland, New Zealand, and Italy is power harnessed by the use of subterranean steam. The Italian State railways use this geothermal source to feed power from their stations in Larderello, Tuscany. From 1818 the " soffioni " were exploited for their boric acid, but today the main use is the production of some 260,000 kW from 75 wells between 500 metres and 1,000 metres deep. The steam issues at 200° C., with pressures varying from 4 atmospheres to 33 atmospheres. This is piped to the power stations and today is fed direct to turbines or, where the boric acid content is high, after extraction of this substance. The corrosion problem mainly affects condensers and turbine blades, the latter lasting some 18 months. The wells are inter-connected and increased tapping of the source does not increase the available power. Research and development of other sites in the locality are in hand. The phenomenon is believed to arise from seepage of rainwater down to plutonic intrusions some 5,000 metres below the surface, followed by build-up beneath an impermeable layer of clays.

* * *

The exploration of Canada's Arctic archipelago is proceeding on a big scale. Complete coverage of the Arctic on a scale of 1 in. to four miles is planned by 1968, additional to much bigger scale maps of areas of special interest. Systematic work began in 1949 and the present two-year programme is mainly concerned with Axel Heiberg and Ellesmere. Ships, foot parties, and dog teams still do much of the work, but helicopters and light planes have speeded things up. Geological reconnaissance have located potential oil and gas fields and some 37,000,000 acres are now being studied by 23 companies ; this should soon lead to two exploratory drill holes. Already the question of transport of the yet untapped oil is under consideration. Among the other projects taking shape is the exploration of the polar shelf north and west of the Arctic archipelago. Air and ground parties have been at work since 1959, using a Decca electronic system for ground positioning.

* * *

The disconcerting resumption of nuclear testing by the Russians may give a green light to the U.S. Atomic Energy Commission's scheme for blasting out a harbour at Point Hope in Alaska (project Chariot). The main problem is the assessment of the radioactive hazard which would be created by the detonation of five charges, one equivalent to 200,000 tons of T.N.T. and the others to 20,000 tons apiece. The hunting grounds of some 700 Eskimos are involved and the final decision has not been taken. Two conflicting appraisals have been made, that in favour of taking the risk of contamination by the Atomic Energy Commission and that against it by a Committee for Nuclear Information. Both draw on common sources of information and agree on one point—that not enough is known to make a reliable forecast. The blast would redistribute some 30,000,000 cu. yd. of debris over the barren countryside and leave a 1,500-ft. diameter harbour approached by channel 2,000 ft. long. The objectives are experimental, meant to tell engineers something of the possibilities of this type of earth-moving. The risk lies in the unknown secondary effect on the lichens, through to the grazing herds, and thence to the Eskimos, whose main meat diet is caribou. There should be no general fall-out effect such as occurs with an exploded nuclear weapon, but past experience shows that the rise of strontium 90 in these regions is higher than in more southerly zones where radioactive fall-out was actually higher, since Arctic lichens take up undiluted fall-out minerals from the soil. Most of the " hot " material should be trapped in the debris created round the blasting site which is expected to lie 100 ft. deep at the crater edge and ½-in. deep a mile away. The whole amount should be less than that to which a television watcher is exposed, but the big question-mark is the cyclic effect on the food chain. Sooner or later these matters must be tested. Perhaps the project is the safest yet envisaged.

* * *

Superficially considered one simple solution of London's mounting traffic problem would be the development of the underground system. On closer examination the matter is far from simple. Consider one bad bottle-neck in the existing tube system—the 2½ miles between Greenford and Potter's Bar through which 350 trains pass daily. This project, now in hand, involves three new twin-tracks, widening of existing cuttings, alterations to a road bridge, and other major matters, such as 68,000 tunnel lining segments and 3,500 inverts weighing 4½ tons apiece. The three new tunnels have an external bore of 31 ft. to allow for future overhead electrification and when lined an internal bore of 26½ ft. The entry for the first 30 ft. is lined with cast iron to facilitate take-up of the thrust of the driving shield. From then on voussoirs (pre-cast interlocking concrete segments) are erected as rings, no bolts or grouting being used. Each ring consists of a reinforced invert with three segments on each side as the lower half, the upper part having 13 segments. The upper half is next jacked away from the bottom part and so forced against the roof of the excavation, while a dry concrete mix is used to fill the gap and complete the section. A super-sulphated acid-resisting cement is used, which is not affected by fumes. All this costs money.

* * *

Braking tests show that car wheels made of aluminium respond more efficiently to retardation than do those of conventional steel ones, because they remain cooler. Brake linings fall off in efficiency (brake fade) above 600° F. and in comparable severe tests steel wheels rose to 925° while those of aluminium stayed below 500°. Time needed to bring the wheel to a stop from 70 m.p.h. was hardly affected for aluminium, but more than trebled in the case of steel.

* * *

Among the " Technical Digests " issued in recent months by D.S.I.R. several could be of interest to mining men. Perhaps the most intriguing, which was demonstrated on television in connexion with its possibilities for high-speed traction, is the linear induction motor, which has a flat " armature " that constitutes the rotor element of the motor. In a belt-conveyor the belt would be made of conducting material and do away with the need for a driving pulley. The system for this purpose was illustrated in *Engineering Materials and Design* for June, 1961. . . . A new electro-magnetic vibrator reverses the static weight—fixed weight ratio by carrying the armature in a lightweight bottom unit and the laminations and coil in the upper moving unit. . . . Soldering of magnesium is facilitated by first plating it with zinc from a sodium zincate solution and following this with successive platings of copper and tin. . . . A telephone system for noisy colliery workings developed by the National Coal Board has

up to 24 loud-speaking units spaced along the coal face and might be useful under other noisy industrial conditions. . . . A magnetically held tee-square can be made by fixing two bar magnets in the head of the square and screwing a strip of steel along the edge of the board. . . . Tractor tyres can be fitted with a flexible small-link armouring of chain mail which greatly reduces tyre wear and is said to improve grip. . . . A new density gauge intended to give a continuous record of pulp flowing through a pipe consists of a unit clamped round its outside, which carries a radioactive source on one side and a measuring arrangement which controls a recorder on the other; 1% variation in solid content of a coal slurry was shown. . . . A silica analyser for boiler feed water makes a complete colorimetric determination in 12 minutes. On the office desk a new rubber stamp made of porous rubber does away with the need for frequent inking.

Book Reviews

Three Geological Reports

Federation of Malaya : The Geology and Mineral Resources of the Kinta Valley, Perak. By F. T. INGHAM and E. F. BRADFORD. Geological Survey District Memoir 9. Cloth, large octavo, illustrated, with maps. Price $10 (Malayan). Ipoh : Geological Survey Headquarters, P.O. Box 1015.

This volume will be an indispensable reference work to all who are interested in the geology of Malaya, with particular regard to its mineral resources. Apart from discussion of the geology and, naturally, of the mineral deposits, there are useful production statistics for all leading properties over a number of years. The memoir is well arranged and produced, although, for the ignorant and the forgetful, the nature of the abbreviation "k.c.y." might have been more clearly marked, particularly as kilos were referred to in the text nearby.

One interesting fact, although well enough known, is emphasized by this volume and that is how little we know about the future reserves of tin ore from alluvial fields of the world. The memoir appears at a time when the world is much concerned with what is believed to be a severe long-term shortage. The reviewer does not disagree with this opinion, but does feel that we do not *know*.

R. A. MACKAY.

The Geology of Sarawak, Brunei, and the Western Part of North Borneo. By P. LIECHTI, in association with F. W. ROE and N. S. HAILE. Paper boards in two volumes, I (text) and II (portfolio) maps. Price M$21 or 49s. Kuching, Sarawak : Geological Survey Department.

This most interesting production is the joint work of the Royal Dutch Shell Group and of the Geological Survey of Borneo and represents a great many man-hours of work, the bulk of which being by the former organization. It is, of course, a success story, inasmuch as it culminated with the discovery of useful amounts of oil.

The bulk of the work is taken up with the stratigraphy of the country followed by a shorter coverage of the igneous rocks, tectonics, and geomorphology. Apart from oil, a little bauxite has been developed. Gold in quite unimportant amounts has been produced and rock phosphate is mentioned. Coal is recorded as potentially of importance.

It is interesting to note that photogeology has played a dominant part in the mapping of the country and it has had great importance in the production of the excellent half million scale geological maps, which accompany the volume.

R. A. MACKAY.

Sarawak : The Geology and Mineral Resources of the Lower Rajang Valley and Adjoining Areas. Geological Survey Memoir 11. By E. B. WOLFENDEN. Paper boards, 167 pages, illustrated, with map. Price 14s. Kuching, Sarawak : Geological Survey Department.

This volume deals with the geology of 10,000 sq. miles in Sarawak. The information is mainly of academic interest and the area does not seem to be well endowed from a mineral point of view. There is some coal which is neither of outstanding quality nor satisfactorily placed to be of use. Apart from this very small amounts of antimony, gold, monazite, and bauxite are recorded and there are constructional materials should they be required in future. Ground water is also considered.

The volume is produced with the usual care and presentation which we have come to expect from the Borneo Geological Survey.

R. A. MACKAY.

The Flotation Index for the Year 1960. Prepared by the staffs of the Chemical Library and Technical Service and Development Department. Paper boards, quarto, 35 pages. Midland, Michigan : The Dow Chemical Company.

The useful little guide book to flotation literature is the 21st annual addition to previous indexes published by the Dow Chemical Company. Section I contains journal references, arranged in alphabetical order, extracted from the world's technical Press and the proceedings of institutions. Section II lists patents granted in different countries. Section III covers books, documents, and symposia, and Section IV a subject index of the whole text.

☛ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 482 Salisbury House, London, E.C.2.

News Letters

BRITISH COLUMBIA

September 6.

Mineral Production.—New records are being established in British Columbia in the staking of mineral claims and in the value of mineral production. Late in August the Hon. W. K. Kiernan, Minister of Mines and Petroleum Resources, stated that prospecting activity is twice as great this year as it was in 1960 and "miles ahead" of the ten-year average. He noted an absence of spare geologists, mining engineers, and prospectors, all being actively engaged in the search for mineral deposits. The Minister credits this satisfactory condition largely to the Japanese markets for British Columbia's mine products and also to the Japanese willingness to subscribe to the development and mine-preparation costs in advance of production. Barring an unforeseen collapse of the price of metals he forecast a material increase in the value of 1961 over that of 1960 and predicted the value would swell to approximately $250,000,000 in 1962.

Company Affairs.—With the lifting of forest closure regulations Qualicum Mines, Ltd., was preparing to commence production in September from its property near Courtenay, on Vancouver Island. A good truck road has been constructed to the property and the pit has been equipped with all necessary machinery, enough of the ore zone having been stripped to permit a start of mining operation. The company has arranged with Vancouver Barge Transportation, Ltd., for the carriage of higher-grade ore directly to the Tacoma smelter and of milling-grade material to the custom concentrator of the Howe Sound Co. at Britannia Beach. The issued stock of Qualicum Mines is held 65% by the Mt. Washington Copper Co., Ltd., and 35% by Noranda Mines, Ltd.

An interim report to shareholders by Bralorne Pioneer Mines tells of a vigorous exploration programme now in progress. Surface work on the Ace holdings has exposed additional veins carrying appreciable values in antimony and gold. One structure now being systematically trenched has displayed a continuous length of more than 400 ft. assaying 3·0% antimony and about 0·1 oz. gold per ton across an average width of 3·5 ft. An exploration option has been taken on the Little Fort molybdenite and gold prospect situated 50 miles north of Kamloops, where prior owners had recently undertaken a diamond-drilling programme that is reported to have produced encouraging results. Bralorne is to attempt to confirm these and further expand the picture. An exploration option has also been acquired on the copper property of RubyMac Mines, Ltd., at Boundary Falls, where the vendors have exposed new and imposing copper mineralization as the result of a bulldozing programme. Bralorne is to continue the surface work and commence diamond drilling early in September. An economic reassessment is at present being made of the Baltic and Braminco gold prospects, in the Renabie district of Ontario.

Toluma Mining and Development expended $102,409 on the development of the Copperada copper property, seven miles north-west of Nicola, in less than a year since commencement on September last, according to a certified statement for Guichon Mine, Ltd. The contract calls for a minimum annual outlay of $100,000 and, in the event of production, Toluma will acquire a 60% interest without return of pre-production expense. Guichon Mine has also farmed out its Quilchena gold prospect on a similar arrangement to Quilchena Mining and Development.

General Resources, Ltd., has purchased 24 mineral claims adjoining its Wade group in the Merritt area. The company has been carrying on an intensified exploration programme on the Wade group. Payment for the new claims was $2,100 in cash *plus* issue to each of the six vendors of 2,000 shares of free stock.

Development work on the property of Galaxy Minerals, Ltd., is pointing toward production. At the annual meeting Dr. P. C. Badgley, of Denver, Colorado, the consulting geologist,

said there were at present indicated some 2,000,000 tons of ore grading between 1·5% copper and 2·0% copper in two parallel deposits in the company's property south of Kamloops. He said this could be mined by standard underground methods at a profit. On the other hand, diamond drilling now in progress is seeking information from an intermediate anomaly in the hope that sufficient material of ore grade may be found to make the whole width commercial. Should this quest prove successful, Dr. Badgley said the whole deposit could be mined by open-pit methods and a good-sized operation should ensue ; if it should fail the two adjoining properties, owned by Kamloops Copper and Makaoo Development, were also showing promise of substantial tonnage of ore. It was entirely feasible, he said, that the three mines could jointly support a fair-tonnage milling operation.

Makaoo Development is now selling capital shares in order to finance the active exploration programme in progress at the property south of Kamloops. Two holes are being drilled and the president and general manager, Mr. W. I. Nelson, is confident there will be a considerable expansion of the 300,000 tons of ore blocked out in 1956.

Reclamation of the main shaft in the Iron Mask mine through the use of a power shovel equipped with a clam-type bucket is proposed by Kamloops Copper. The company's engineering advice is to the effect that such a method would provide quicker re-entry into the underground workings than through the unwatering of the Norma shaft.

Fill-in drilling is in progress to determine continuity between a significant drill intersection and previous ore intersections 450 ft. to the east in the Hedley Monarch property of Friday Mines, three drills being in use. Geological mapping on the Sunrise claim has provided valuable information relating to longitudinal extensions of the Sunrise and Sweetner veins and additional detailed mapping was scheduled for completion by mid-September. Sampling of stripped outcrops is being done in quartz veins exposed at 200 ft, 400 ft., and 700 ft. west of hole No. 4 and believed to be the extension of the Sweetner vein. Another exposure is in line with and suggests and extension of 750 ft. in the Sunrise vein. In addition to the work in the Hedley Monarch gold property an audio-frequency magnetometer survey is being run on the Copper King claim in the hope of developing massive deposits of copper.

With apparent success in its chemical-grouting operation to contain the " Cariboo Slum " on and above bedrock of Lightning Creek in the Cariboo district. Wingdam and Lightning Creek Mining is rapidly lowering the water in the Melvin shaft, which is sunk in hard rock on the rim of the creek bank. In anticipation of early production the company is accelerating the reclamation programme.

In a statement to shareholders Mr. L. J. Randall, the president of Hecla Mining, advises that the company has granted the right to explore and develop the Red Bird group of 16 Crown-granted claims near Salmo to the Consolidated Mining and Smelting Co. of Canada. Cominco, which holds adjoining ground to be included in the common project, will bear all expense and, should the effort result in production, will be entitled to a 68% interest in earnings. The property is a lead-zinc prospect.

Shareholders of Sheep Creek Mines learned at the recent annual meeting that the new low-level adit is being driven from the opposite (the Jumbo Creek) side of the mountain to the present workings of the Mineral King mine. The new drive extends toward the hanging-wall and is expected to encounter the favourable zone within 1,200 ft. from the portal. Mr. H. E. Doelle, the managing director, told the meeting that the transportation of ore would be difficult at first, but that raises could be driven to existing arteries on the mill-level horizon and the ore hoisted to that level. Mr. Doelle said silver production, while minor, was increasing and recovery of metals was high, the mill operating smoothly at 600 tons a day. Mr. M. M. O'Brien, a director, referred to the Mineral King mining operation as " the most efficient in Canadian history." The managing director told the meeting there was at present no market for barite, which in recent years has brought some revenue as a by-product.

Yukon.—An important discovery of a silver-lead-zinc-copper prospect, about 100 miles north-west of Watson Lake was reported late in August to have been made by the partnership of Conwest Exploration and Central Patricia Mines, in which the former holds an 80% interest. The find is the second to be made by the same companies and is about 24 miles south-west of the earlier discovery, a copper-zinc prospect at North Lakes. Silver assays have run from 50 oz. to 350 oz. per ton, with lead from 30% to 60% and copper in the range of 3%, the silver occurring with galena in tetrahedrite. The occurrence, from the limited amount of work done to date, appears to be a series of fracture veins located in a shear zone. In addition to the two Conwest-Central Patricia discoveries Cassiar Asbestos, a Conwest associate,

recently made a copper discovery at Fire Lake, some 14 miles due south of the North Lakes property and is now carrying out its own exploratory programme.

Shareholders of Centennial Mines were informed at the recent annual meeting that one exploration project in Yukon has been abandoned and that two other prospects are now being examined. The Lened prospect, which is situated near the highly-rated Flat River property of the Canada Tungsten Mining Corporation, was explored in detail by diamond drilling and by surface geological mapping. On final evaluation of results, however, it was decided to end all work as insufficient tonnage of ore-grade tungsten mineralization was indicated and projected. The company is conducting a general exploration programme in Yukon. The company has also discontinued field work on the Duncan prospect, in the Keno Hill area, but is maintaining its search for high-grade silver-lead prospects in that general area.

New Imperial Mines has announced its success in obtaining an underwriting with sufficient firm commitment to conduct an ambitious exploration programme on its three properties in south-western Yukon. The company holds a large block of copper claims four miles west of Whitehorse. The mineralization contains copper, iron, and traces of gallium. A second holding is the Jean group of 15 claims, nine miles south of Carcross and 67 miles north of Skagway. Imperial also holds the Montana group of six claims, three miles south-east of the Jean group, with which it is connected by road. Some work was done of the Montana 60 years ago and the property showed promise. A selected sample recently taken assayed 0·08 oz. of gold and 128 oz. of silver per ton, with 44·6% lead.

Kootenay Base Metals has constructed 5½ miles of jeep road to connect its new camp at the recently-acquired silver-lead prospect near Teslin Lake with the Alaska Highway. Mr. J. D. Mason, a director, reports one new trench on an extension of the No. 6 vein as assaying 0·08 oz. of gold and 90·3 oz. silver per ton, with 14·3% lead.

Peso Silver Mines claims to have made an important silver discovery 15 miles west of the United Keno Hill mine, at Elsa. One vein is reported to extend 700 ft. on surface with average width of 11 ft., while in a pit sunk to a depth of 20 ft. the vein, which assayed 15 oz. of silver per ton at surface, the ore was found to increase to 65 oz. at bottom. It is planned to convert Peso Silver into a public company. Control is held by Tanar Gold Mines, Ltd., a private company.

EASTERN CANADA

September 23.

North-Western Ontario.—During 1960 Young-Davidson Mines carried out test work on an asbestos prospect in McCool township. Some 2,500 ft. of drilling was done and mill testing showed interesting amounts of short-fibre asbestos. Further work is being done in the current year to enable a final appreciation to be made.

Cobalt.—A new 400-ft. shaft in the Cobalt area is planned by the Mentor Exploration and Development Company. To be put down on ground previously unexplored it will be a three-compartment shaft and enable a programme of cross-cutting, driving, and diamond drilling to be carried out underground.

Saskatchewan.—A new rich gold find in the northern part of the Province has been reported by Augustus Exploration, which, in conjunction with Rayrock Mines, is exploring in the Centre Lake area, about 90 miles east of Lac La Ronge.

Manitoba.—At the annual meetings of San Antonio Gold Mines and its subsidiary Forty-Four Mines held recently in Winnipeg shareholders were informed of recent promising developments at the Forty-Four property. On the new deep levels put in from the internal shaft unexpected ore finds have been made. In 1960 Forty-Four Mines made a loss of $122,199. a result expected to be much improved in the current year.

Sherritt Gordon's copper-zinc property at Tod Lake is to be drilled for testing and a contract has been let. The find is situated about 30 miles south-west of Lynn Lake.

Quebec.—Marbridge Mines, formed last year by Falconbridge Nickel Mines to develop the nickel property in the Val d'Or area of north-western Quebec formerly owned by the Marchant Mining Company, is expected to be carrying out ore testing by the end of 1961. The Canadian Malartic mill is being extended to carry out the work. Four levels have been put in and drilling is to be carried out at the 750-ft. horizon.

During the first quarter of the current year Canadian Malartic milled 115,932 tons of ore and produced bullion valued at $365,502. The profit for the period was $18,967.

AUSTRALIA

September 20.

Oil Search.—The valuable assistance given by the Commonwealth Government to the search

for oil in the year 1960–61 is illustrated in the annual statement by the Minister for National Development on operations under the Petroleum Search Subsidy Acts. Under the present Act 89 applications for subsidy were dealt with ; 23 were for stratigraphic drilling, including six for off-shore drilling, 47 for seismic surveys, 11 for gravity surveys, six for aeromagnetic surveys, and two for borehole surveys. Subsidy payments amounted to £A1,147,125 and the outstanding subsidy commitment at June, 1961, was £A,570,210. There has been criticism in the Press to the effect that the Government is not providing enough money to subsidize oil search, but the Minister has stated that up to the present very few eligible applications for subsidy have been rejected on account of shortage of funds.

Gold.—Mine production of gold in Australia for June, 1961, was 83,836 fine oz., bringing production for the first six months of the year to 511,692 fine oz., 14,175 oz. less than that for the same period last year. The June production was, however, 2,197 more than that in May.

The general position is depressing, for the large producing mines show shrinking ore reserves, together with a slight increase in grade, indicating some re-assessment in the reserve position. Wage increases awarded by the Industrial Courts in the year amounted to 12s. 1d. per week, but with no increase in district allowances.

There has been a development of some interest, but of doubtful importance, in the mine of Australian Development, at Tennant Creek. The sinking of No. 12 shaft reached a depth of 81 ft. and ore raised from this horizon assayed 40 dwt. gold per ton. Recent surface diamond-drill holes have, so far, indicated that the high values are limited to this particular area and do not appear, at present, to be part of a large orebody. The development is at about the 330-ft. horizon, east of the main orebody. The mine is consistently milling ore of a 40-dwt. head value. Ore reserves are estimated at 158,000 tons and have approximated this tonnage for several years, accessions to reserves coming from lateral development. Exploration at depth has been unproductive, although there does not appear to be any change in geological conditions. It is stated that the company is spending £A60,000 per year in the search for new orebodies.

The Peko gold-copper mine has ore reserves of about 1,000,000 tons and is shipping copper concentrates to Japan. Prospecting of the Orlando lease, eight miles west of Australian Development's Noble's Nob mile, has disclosed a gold-bearing lode, with some copper, which has been traced for about 1,200 ft. This was located by drilling an anomaly for copper. The high gold values obtained in drilling have not been maintained in subsequent underground development, but the first milling of ore from this work, amounting to 700 tons, gave an average of 11 dwt. gold per ton and 0·7% copper. It had been hoped, from the diamond-drilling indications that a larger and higher-grade lode would result. Development is being continued and the Peko company is erecting a treatment plant suitable for this ore with a capacity of 100 tons per day.

Gold-mining subsidies paid by the Commonwealth Government in 1960–61 totalled £A698,657. Payments were made to seven big and a number of small producers whose individual output was less than 500 oz. of gold for the year. While this subsidy is helpful it is insufficient to encourage prospecting and exploration and has little effect on additions to ore reserves. It does, however, help to preserve the industry and maintain population in outback areas that otherwise could be deserted. The relief given by the subsidy is absorbed by the periodical wage increases.

Asbestos.—A promising future is indicated for Australian blue asbestos, of which there is a large available tonnage in the Hamersley Range country of Western Australia. While local consumption is relatively small an important export market has been built up by the operating company and improvements and additions to the mill have been carried out in recent months. The fibre-bearing rock occurs in horizontal beds exposed in gorges intersecting the range and worked by tunnels and modified coal-mining methods. New South Wales and Western Australia have important resources of chrysotile asbestos, which are not being worked on a scale commensurate with their indicated importance, but there is a small if regular production of fibre from the Pilbara region, north of Wittenoon, in the Hamersley Ranges, mining being by underground methods. In New South Wales, at Baryulgil, in the north-east of the State, one company is in regular production by open-cut methods and surface drilling and surface examination have indicated attractive prospects for large-tonnage mining by open-cut. The serpentine belt is not large but offers scope for important intensive exploration.

Iron Ore.—Export of iron ore continues to figure very largely in Australian mining, linked with the development of Western Australia's iron-ore resources. Optimism in the prospects of this trade was damped somewhat by adverse opinions on the prospects of leases taken up near

the Broken Hill railway in South Australia, which failed to measure up to the anticipations of the applicants. A great disappointment was the abandonment of negotiations by the Japanese for the Mount Goldsworthy iron-ore deposit, inland from Port Hedland, for the reason that information submitted had greatly overestimated the tonnage and grade of the ore. An additional reason was that the harbour of Port Hedland could not be made adequate for the ships that would be needed to deal with the anticipated export of 1,000,000 tons of ore per year. Although unwilling to put capital into Mount Goldsworthy the Japanese would be prepared to buy ore.

Mount Isa.—A new ore-dressing mill is to be built at Mount Isa Mines, North Queensland. Planned capacity of the mill is 14,400 tons of ore per day, as compared with the capacity of the present mill, which is 8,000 tons per day. The cost of the new plant will be £A9,000,000. Construction will be concurrent with the sinking of the new main shaft, which is designed for the maximum capacity of the new mill. Date for completion is 1964 and by that time the reconstruction of the Townsville–Mount Isa railway will have been completed and the line be able to deal with the full anticipated traffic between mine, copper refinery, and the Port of Townsville, as well as the intermediate traffic from the cattle stations to the coast.

Coal.—The export of coal, linked with the improvement of the coal ports to load and accommodate the large colliers to be put into the trade, is to receive substantial assistance from the Commonwealth Government. The amount of £A2,600,000 is to be made available to the New South Wales State Government to carry out the necessary work at Newcastle, Balmain, and Port Kembla. Despite increased domestic and overseas demand for coal the Joint Coal Board has warned the coal-mining industry that the present over-production cannot be continued and that stockpiles are increasing. Measures in progress to meet the position are the increasing of export to Japan and the approaching completion and operation of the new power houses at Vale's Point, Lake Macquarie, New South Wales, which in 1963, will require 2,500,000 tons of coal per year. The great expansion of the steel industry in Australia means a substantial increase in the demand for coal.

The Queensland Government is following the lead of New South Wales in building steam-generated power houses at the coalfields themselves. Two are to be built in Queensland, one at West Moreton, drawing coal from the Ipswich field, and the other on the Callide field, inland from Gladstone. The West Moreton power station is expected to cost £A36,000,000 and a first stage Callide station £A9,000,000, to be developed ultimately to a plant costing £A23,450,000.

Port Kembla Coal and Coke Pty, is to build an off-shore coal loading plant at its Coal Cliff colliery at a cost of £A2,500,000 which will handle the largest colliers. Coal will be conveyed from a mine stockpile holding 300,000 tons by conveyor-belt, loaded by a bucket-wheel elevator. The delivery point will be one-half mile out to sea. Commonwealth Government assistance to port improvement is for loading equipment; provision of deep-water berths will be financed by the State Government.

FAR EAST

September 20.

Malayan Tin Industry.—Speaking recently in Kuala Lumpur Mr. D. R. Mitchell, president of the F.M.S. Chamber of Mines, said that the need for intensified prospecting for tin was more than ever apparent. Addressing shareholders of Kuala Kampar Tin Fields, Ltd., he suggested the Government might regulate its departments dealing with applications relating to tin mining. He said: "It is to be hoped something can be done to streamline the manner in which applications for prospecting permits and indeed all applications relating to tin mining are dealt with by the Land Office and the Government departments concerned."

Dealing with the new International Tin Council, he said the problem facing it was quite the reverse to the one which brought the first agreement into force in 1956, when conditions were such that a burdensome surplus of supplies was foreseen. The present problem was distinctly one of shortage of supplies. He reminded the meeting that all but a very few of Malaya's tin dredges and much of the capital equipment employed on the other types of tin mines in the country were bought pre-war at a fraction of the cost that similar plant would cost new to-day. Mr. Mitchell also said that "while it is not in the interests of anyone connected with tin, whether on the producing or consuming side, that a situation should arise under which the demand for the metal cannot be met, the problem of

shortage of supplies will not be solved in the long-term sense by a decision on the part of the United States Government to make releases from the strategic stockpile." It was to be hoped, therefore, that if in the future any releases were made they would be geared to price levels and limited to quantities which would neither disturb the market nor discourage producers in their plans to expand their operations. Otherwise, the effects would be disastrous.

Mr. Chong Khoon Lin, president of the All-Malaya Chinese Mining Association, said in Ipoh that the high rate of contribution to the International Tin Council's new Buffer Stock was discouraging the recovery and expansion of mining operations in Malaya. Speaking at the Association's annual general meeting, he said they had appealed to the Government to reduce the rate of contribution—(Malayan) $36 a picul, which is equal to about 133 lb.—to the new Buffer Stock, suggesting that this high rate had imposed a heavy burden on Chinese tin miners and made it uneconomical for "marginal" mines to operate.

Following the reply by the United States Government to the Malayan Government's protest on the subject of announcements on tin stockpile disposal, the *Straits Times* has suggested that if the U.S. Congress authorized sales, the General Services Administration should decide on the rate and conditions of release only after full consultation with Malaya and other interested countries.

North Borneo.—A Japanese firm, the Teikoku Oil Company, was recently granted oil prospecting facilities for two months over several areas on the east and north coasts of North Borneo. Representatives of the firm arrived in Jesselton for a tour of inspection of Sandakan, Tawau, and Lahad Datu.

The Shell Company of North Borneo, Labuan, has announced that no oil has been found at the Emerald shoal offshore exploration well. This well, drilled to more than 8,000 ft., has been abandoned, but the company said geological information gained there would be of use in determining the prospects in nearby areas. The mobile oil-drilling barge the *Orient Explorer* has been moved from the Emerald shoal to the Barton location.

India.—The wide cold strip mill of the Rourkela steel plant went into regular production recently, marking the completion of the rolling mills except for the tin plate producing units. The cold strip mill, the first of its kind in the country, will turn out 170,000 tons of high quality cold roll sheets annually.

SOUTHERN AFRICA

September 26.

Union Affairs.—Over the first seven months of 1961 imports into South Africa were valued at R622,643,000, exports at R541,106,000, and the trade deficit at R81,537,000. With the corresponding 1960 figures in brackets, individual exports in the first seven months of 1961 included the following: Mining machinery, R5,899,177 (R5,992,328); chromite, R1,942,399 (R3,805,656); lead concentrates (re-exports), R5,197,600 (R7,313,358); manganese ore, R5,697,883 (R6,131,574); fire-refined and blister copper, R11,898,853 (R12,820,536); asbestos, R14,024,232 (R14,463,034); coal, R2,752,484 (R2,614,246); diamonds, R46,385,854 (R42,384,148); radioactive mineral (U_3O_8), R44,995,481 (R64,637,042).

Of South Africa's gold output of 21,383,019 fine oz. in 1960 (estimated at 63·1% of world output) direct sales by the S.A. Reserve Bank to private purchasers outside the sterling area amounted to 6,000,000 oz. in 400-oz. bars and additional sales by the Transvaal and Orange Free State Chamber of Mines to similar purchasers to about 350,000 oz. in kilo gold bars. On behalf of the Chamber the Witwatersrand University is undertaking research work into certain aspects of the properties of gold alloys.

During 1960 recruiting of young men overseas for training as miners in the Government Miners' Training Schools was suspended and in that year 1,256 trainees (1,212 local and 44 overseas) entered the schools, while 512 (355 local and 157 overseas) completed their indentures. At the end of 1960 there were 1,357 trainees (1,229 local and 128 overseas) in the schools.

In his presidential address to the South African Institute of Mining and Metallurgy, reviewed later in this letter, Mr. D. G. Maxwell, who kept well away from the genesis of the Witwatersrand goldfields, estimated the uranium reserves of the field at 370,000 tons of U_3O_8, quoted Buchmann as having estimated a deposit north of Bothaville at 100,000,000 tons containing about 70% heavy minerals, including ilmenite and leucoxene, rutile, zircon, and monazite, the exploitation of which awaits more favourable market conditions, referred to the thousands of millions of tons of titaniferous magnetite in the basic rocks of the Bushveld igneous complex containing 70% to 85% iron oxides, 14% to 20% TiO_2, and 1% to 2% V_2O_5, the known reserves of high-grade limestone at about 2,000 million tons and the dolomite reserves as being almost unlimited, the reserves

of iron ore (25% to 70% Fe) at 2,000,000 million tons (including titaniferous ores), the reserves of manganese ore (35% to 54% Mn) at 10,000 million tons, and the reserves of chromite, very conservatively, at 200 million tons (38% to 50% Cr_2O_3).

South African Institute.—Following Mr. D. G. Maxwell's presidential address to the South African Institute of Mining and Metallurgy, Mr. T. L. Gibbs, Acting Government Mining Engineer, commented that a forecast of the value of mineral production in the Republic up to 1990 compiled by his Division of the Department of Mines, shows that the peak of gold production will probably be reached in 1970. The value of base mineral production will continue to rise, he suggested, while by 1990 the value of manganese and chrome ore production will be about treble the 1960 figure, and the value of coal production will be nearly double the figure for that year. Mr. Gibbs also pointed to the active steps being taken by the Government to ensure that the country derives the greatest benefit from its mineral production, through the domestic processing of as high a percentage of mineral output as possible. The Income Tax Act of 1961 permits a more generous capital allowance for all base-mineral mines and encourages domestic processing of production by allowing the percentage of new capital written off to reach 100%, dependent on the degree to which the product mined is processed in the country. An inter-departmental committee has been established to investigate all export minerals from the aspects of reserves, production potential, practicability of processing, markets for the processed product and all other relevant aspects.

In his address Mr. Maxwell suggested that South Africa is on the threshold of a new mining era, the base-mineral era, in expectation of base minerals becoming eventually and collectively the most important factor in the country's mining and mineral activities. Mining activity in South Africa has been characterized by two major eras—the diamond era prior to 1886, when the gold era was ushered in with the discovery of the major economic gold reef of the Witwatersrand, the Main Reef. The diamond era, Mr. Maxwell said, provided an excellent foundation for the gold era which, while still to reach its peak, can provide resources destined to play an even more important part than they do at the present time in the mining industry's third era, the threshold of which has now been reached.

Mr. Maxwell dealt with the processing of minerals and metals as an innate division of mining activity, as opposed to manufacturing industries, which produce consumer goods from the products of the mining industry.

In tracing the lines of further advance Mr. Maxwell pointed to the production of superfine gold being investigated to the disparity of revenue from coal burnt as fuel (of the order of a Rand or so at pithead), and that from its use in the oil-from-coal project (from which revenue with by-products is about R10·00) to the production of uranium metal and compounds from U_3O_8, the present end-product, to the production of electrolytic copper, to full-scale refinement and separation of platinum-group metals in the country, to further extension of processing manganese ore in the country, particularly for the export market, to the possibilities of expanding the uses of the country's chromite in extended manufacturing of ferrochromes and chrome chemicals, to the scope offering for the production of special and stainless steels and other alloy steels, to specialized refining of tin, to expansion of nickel production and the development of suitable treatment methods, to the future scope for exploiting titanium and associated resources, to prospects for beryllium, to the zirconium potential, to a more distant study of the best uses of vast reserves of dolomite, and to the prospects for the interesting Phalaborwa complex. He emphasized the role of the metallurgist in the new era, since the geologist is already far ahead of his natural follower and since the metallurgist has a major task to turn the mineral resources discovered by the geologist into economic ore reserves. Intensified research in many references and especially in connexion with the development of new processes rather than adaption of existing processes received detailed emphasis in the address. With gold-mining activity expected to decline in the near future, both money and energy will become available for the new era, but this re-orientation should be accelerated and receive encouragement, not least through the provision of Governmental incentives and preferential fiscal treatment and the bestowing of greater status on entrepreneurs.

Gold.—Under the influence of expanding gold-mining activity in the Kinross area of the south-eastern Transvaal—where the Winkelhaak mine is now an established producer and the Leslie and Bracken mines are nearing the production stage—it has been estimated by the Natural Resources Development Council that the total population of the controlled zone (from Devon in the west to Trichardt in the east) will be at least 122,500 in 1970 (of whom about

27,500 will be whites), against 39,900 in 1955 (of whom about 4,000 were whites).

Swaziland Protectorate.—Some R18,000,000 is to be spent on the construction of the first rail-line in Swaziland from the western terminus at the iron-ore deposits of the Swaziland Iron Ore Development Co., Ltd., at Bomvu Ridge (about 10 miles north-west of Mbabane), through 136 miles of the central districts to the common eastern boundary with Portuguese East Africa. Thence another six miles of track will be constructed by the Portuguese authorities to the Goba siding on the main line to the port of Lourenco Marques. To coincide with the completion and commissioning of the rail-line by the end of 1964 the Bomvu Ridge iron-ore deposits will be developed and commissioned for production under a contract now concluded between the Swaziland company and the Yawata Iron and Steel and Fuji Iron and Steel Companies, of Japan, and the shippers, the Hugo Neu Corporation, of New York. Construction will be financed to the extent of about R12,000,000 through loans from the Colonial Development Corporation, the Anglo American Corporation of South Africa, Ltd., and De Beers Consolidated Mines, Ltd. The project will bring to fruition the earlier discovery, surveying, and exploration of the Bomvu Ridge deposits by the territory's Geological Survey and Mines Department, which was followed up by an intensive programme of preliminary exploratory development by the Swaziland company.

The initial open-cast workings at Bomvu Ridge will be about 800 ft. above the rail-siding and terminus, where a washing and screening plant is to be erected. To this plant the ore will be transferred by a conveyor system from a tip receiving ore transferred from the working faces by means of mechanical excavators. The ore reserves, indicated by a surface survey and by borehole data, have been estimated at more than 60,000,000 tons, and the probable reserves at about 40,000,000 tons. The orebodies—consisting of nearly pure masses of iron oxide—are irregular in outline with a roughly lenticular form. The two main bodies so far disclosed are about 2,000 ft. and 1,850 ft. in length on strike, the maximum surface widths being 180 ft. to 400 ft. The grade is understood to be remarkably uniform. The composition is largely hæmatite and specularite with magnetite present. A large number of hæmatite borehole cores averaged 64·89% Fe and 3·56% SiO_2, and hydrated goethite cores 58·38% Fe and 2·93% SiO_2. The relative merits of a hydro-electric generating station and a coal-fired electric generating station are being considered. The former would be sited on the Little Usuta River. The latter is expected to be supplied with coal from the project of Central Mining Finance, Ltd., at Mpaka, where exploratory drilling was followed by sinking an incline shaft to the main seam at shallow depth. The average width of the seam is said to be 7 ft. and to dip at 4° to 5°.

The rail-line will carry general as well as minerals traffic. Generally it will provide a long-awaited stimulus to the territory's economy. Many productive enterprises are expected to be expanded and enterprises which have remained in the planning stage—such as, coal and possibly anthracite and others—are expected to be brought to the producing stage.

Ferro Alloys.—The African Metals Corporation is installing an additional 6,000-kVA electric furnace at its Kookfontein works, near Vereeniging, where an existing furnace is being expanded to 9,000 kVA from 7,500 kVA, and an additional 10,000-kVA electric furnace, with provision for expansion to 15,000 kVA, at its associated ferro-alloy works at Witbank. With these projects completed the group's total installed electric furnace capacity will be raised to 90,000 kVA. The Corporation has vast reserves of low-grade phosphate at Langebaan (in the Saldanha Bay area), Cape Province, bulk samples from which have been subjected to beneficiation tests, seemingly with promising results. Further examination of the project awaits the recommendations of the Commission of Inquiry established by the Minister of Economic Affairs to examine the fertiliser industry of the country ; meanwhile prospecting continues to expand the known reserves. Prospecting is also proceeding in other areas of the Republic and in the Rhodesias. The Corporation also has a subsidiary—the Mineral Development Corporation (Pty.), Ltd., in South-West Africa. At the works at Newcastle, Natal, the new blast-furnace (600 tons per day capacity) contributed markedly to the works' increased output of 122,000 tons of pig iron and 20,000 tons of ferro-manganese to respective totals of 260,000 tons and 26,000 tons in 1960–61.

South-West Africa.—The South African Minerals Corporation is shortly to abandon mineral grant areas over a total of about 4,600 square miles in the general Gobabis area and retain rights over about 167 square miles as well as radioactive mineral prospecting rights to November 30, 1965. The Corporation is retaining its mining rights over about 21,711 acres in the Rustenburg area, Transvaal, and a lease over a small zone in the same area, which rights comprise its chrome and nickel section.

At its manganese deposits in the Gobabis area the underground exploratory development programme was continued but confined in 1960–61 to the areas of surface quarrying below the water-table level. This necessitated provision of additional power and pumping capacity and in one zone cementation. It has been decided to place the manganese workings on a care and maintenance basis while negotiations are proceeding for further exploration of its properties.

Two vessels are to be commissioned for underseas diamond prospecting operations in the immediate future in two concession zones, one extending northwards from the Olifants River on the Namaqualand coast to the mouth of the Orange River and the second from the latter to Luderitz on the South-West African coast. It is understood that concentric pipes will be lowered to the sea-bed; compressed-air led through the inner will agitate the sediments, which will be sucked up the larger, outer pipe.

One of the smaller workers of copper deposits in the territory, the Bulldosing and Prospecting Co. (Pty.), Ltd., is installing a copper leach-plant at Rehoboth, in order to turn out a product economic in relation to the costs of mining and shipping.

Central African Federation.—According to *Optima*—the review of the Anglo American Corporation—a tunnel 14 ft. wide and 13 ft. high was advanced 1,200 ft. in 26 working days; 14½ tons of rock broken per foot advanced being removed by a locally-designed conveyor-train system. This facilitates continuous filling of the cars by a mechanical loader operating from the face and discharging into the first of the conveyor cars after the loco shunting is eliminated. Each of the car units consists of a standard 20-ton tray car, on which is mounted a conveyor-belt carried on a four-wheel chassis free to move along rails on the top of the car and long enough to be able to discharge into the feed end of the next conveyor. The feed end is carried on an independent bogy or chassis, coupled to the tray car. During feeding the feed-end unit is uncoupled from the tray car, which is slowly drawn away by the loco, the discharge end of the conveyor-belt traversing the length of the tray car. Near the tip a gantry lifts the conveyor off the cars which can then be drawn away to the standard tipping device. The installation is at Nchanga Consolidated Copper Mines, Ltd.

With Kariba electric power available it has become possible to establish Windsor Ferro-alloys (Private), Ltd., at Que Que, to produce high-carbon ferro-chrome. The first smelter is expected to be commissioned about mid-1962.

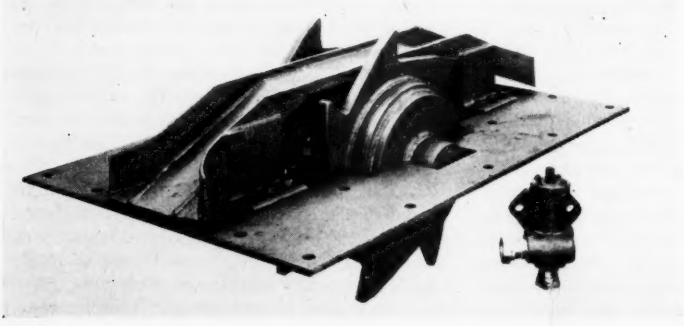
Coal.—The South African Coal, Oil, and Gas Corporation is investigating the economics of gas distribution from its plant at Sasolburg to the various industrial concentrations of the Southern Transvaal. The final decision will be made at the year-end and if positive the project should be completed by about 1965. The main pipe will follow the rail-line from Sasolburg in the Northern Free State to the industrial area of Alberton, near Germiston.

Trade Note

Car Train Control

The introduction of the "Rotarder"—a completely self-contained device to give speed control of a train of tubs or mine cars is announced by **Richard Sutcliffe, Ltd.,** of Horbury, Wakefield. The system contains the Rotarder, the header tank, and one or two valves as required.

Oil is fed by gravity from the header tank into the Rotarder body which is completely filled with the selected grade. As the tub axle pushes the star wheel the rotor revolves and, acting as a pump, passes the oil along the return line back to the header tank. A gate valve is



Sutcliffe Mine Car Control System.

fitted in this return line, the closing of which causes a higher pressure to be generated in the Rotarder with the oil passing either up the restricted return or short-circuited past the brushes or down the sides of the rotor. With the valve completely closed all the oil is short-circuited and the maximum retardation condition is obtained.

A pull-wire-operated quick-release valve is fitted as an optional extra in the return line to by-pass the gate valve. This immediately relieves the pressure in the Rotarder under any circumstances and allows sluggish cars to be passed through. The operation of this valve can be achieved from any convenient position by means of the pull wire and does not affect the original setting of the machine. If tubs are required to be run or pulled through in the reverse direction the stator is so arranged that the oil has a free flow past the rotor blades and, therefore, the resistance to rotation is kept at a minimum. The illustration shows the device and the quick-release valve.

Personal

K. C. ACUTT, recently elected chairman of the Consolidated Mines Selection Co., Ltd., and Lydenburg Estates, Ltd., has resigned from the chairmanship of the Wankie Colliery Co., Ltd., as he is now resident in England. He is remaining a director of the company.

J. M. BAILLIEU and Mr. J. B. HARPER have joined the board of North Broken Hill, Ltd.

R. B. W. BOLLAND, formerly general manager of Head Wrightson Stockton, Ltd., has been appointed London manager of Head Wrightson and Co., Ltd.

E. J. D. BROWN has left for Sierra Leone.

E. T. S. BROWN has been appointed a director of the Anglo American Corporation of South Africa, Ltd.

P. H. A. BROWNRIGG has been elected chairman of the Wankie Colliery Co., Ltd.

H. G. HAGUE, coal consultant to the General Electric Co., Ltd., and a well-known figure in the coal industry retired on August 31, 1961. He had been at the company's Fraser and Chalmers Engineering Works, Erith, for over 38 years.

R. A. HUDSON, formerly export sales manager of Robert Hudson, Ltd., has now been promoted to specialist duties in the company's manufacturing division. Mr. M. J. THEAKSTON, formerly London manager, has been appointed export sales manager. The new London manager is Mr. A. VICKERY. Mr. FRANCIS THEAKSTON is to continue as consultant director in London.

R. I. HUTCHISON has left Canada for South Africa.

S. H. IRELAND has been appointed managing director of the Consolidated Pneumatic Tool Co., Ltd., in succession to Mr. NORMAN READMAN, who becomes chairman of the board.

M. E. PEASE is now a director of the Lampa Mining Company.

J. E. PHILPOTT is leaving for Ghana.

AUSTIN W. SCOTT has been appointed a director of Armstrong Whitworth (Metal Industries), Ltd.

M. W. SEAGER has been appointed chief development engineer of Richard Sutcliffe, Ltd., in succession to Mr. LESLIE BAINES, who has joined the board of Sutcliffe Hydraulics, Ltd.

Sir ALEXANDER SIM has been appointed a director of the Cementation Co., Ltd.

F. E. STUDT was here from New Zealand.

P. M. R. WILLIS is home from Sierra Leone.

Metal Markets

During September [1]

Copper.—After steering a neutral course through the excitements that surrounded the copper market in August and early September, prices [2] in London have declined somewhat latterly, as the copper situation has become more mixed. The feature of the market in the early part of the month was the ending, very close together, of the strikes in Chile and the strike at Kennecott Copper's Bingham mine in the U.S.A. The American strike was determined, but the Chilean strikes were only postponed and have not yet been settled. Meanwhile wage demands for the new contract at the Chuquicamata mine have now been presented—at the same level as was asked by the El Salvador miners before striking. The outlook in Chile, therefore, remains clouded. So too is the prospect in the Congo, where there have been further political disturbances in the past month, resulting in the closure of certain Union Minière mines and plants for four days.

These developments would, in the ordinary course of events, receive a clearly bullish interpretation, especially as other indications of a background nature lead in the same direction. Although European copper consumption is stagnating at the moment, there is considerable optimism in the U.S.A. about the outlook for the fourth quarter of the year and it is expected that copper consumption there will stage a

[1] Recent prices, pp. 200, 240.
[2] See Table, p. 240.

strong recovery in this period. Whether it returns the year's total to a higher level than last year (which could not be forecast on figures up to August) remains to be seen. A reflection of the much better U.S. sentiment is that Phelps Dodge has put its mines back on a full operating rate, after restricting by 10% for a number of months. The fact that European consumers are still paying premiums for spot electrolytic wirebars is a reflection of consumption there remaining at least adequate and it remains to be seen how this premium develops if there should prove to be a short-fall in arrivals from Chile as a result of the strike.

In the face of the foregoing some people are surprised copper is not able to look better. However, it must be remembered that two big producers are still restricting supplies to the market by 10%, which makes a difference. Also, the influence of stocks on market prices is apt to be underestimated. World producers stocks are not going down as might be expected from the production interruptions and, more important, stocks in L.M.E. warehouses are showing a rising trend.

Copper consumption in the U.K. in July was 54,556 tons, of which 40,229 tons was refined. Production was 8,467 tons primary refined and 8,085 tons secondary refined. Stocks of refined copper declined to 119,806 tons.

Tin.—The speculative nature of the London market in the period since the Buffer Stock holdings were exhausted has been well illustrated in September, as the market has been extremely sensitive when there have been any indications of change in the basic situation and still very nervous when nothing new was in fact happening. In the early part of the month it was certainly a problem to know how the situation was going to develop, as the biggest single talking point for tin—the possible release of metal from the U.S. strategic stockpile—became a shuttlecock in a series of on-off reports. The matter was not finally resolved until the end of the month when Congress rose without giving the necessary approval for the release of 50,000 tons of stockpile tin, as had been requested, nor for the release of 10,000 tons of this quantity without the necessary six months waiting period, a possibility that really had the market worried. It had been argued that a growing expectation that this release would not be approved would be the signal for prices to recover sharply from the sort of level to which they sank on its first request.[1] However, tin prices, while never standing still, have held nearer £950 than £1,000 a ton. One factor has been the refusal of consumers to be flapped and there have all the time been small sales from the U.S. non-strategic stockpile. It now remains to be seen what happens at the twice-postponed Tin Council meeting on October 9, but even if a ceiling price of £1,000 is agreed on this need not affect the market immediately.

Meanwhile there is still some basic disagreement as to the interpretation to be put on world 1961 figures, which are now far enough advanced to make annual projections reasonable. While a deficit of 20,000 tons or so is still cogently argued, it has been queried by others, who equally reasonably point to the present lack of any early signs of shortage.

U.K. tin consumption in July amounted to 1,747 tons, with production 2,062 tons. Stocks slipped back to 8,697 tons.

Lead.—Lead prices had, by the end of September, got back to very low levels indeed,[1] although it would be difficult to say in what way the situation was measurably worse than it was earlier in the year, when higher prices ruled. Indeed, since prices were last as low as they are now, there has been the hopeful Mexico City meeting and the U.S. barter. Consumption has remained satisfactory throughout. At the same time the basic problems of lead are grave enough and it would be unrealistic to expect prices to be substantially higher than they are. One thing is certain; present prices will mean that at the next Lead and Zinc Study Group meeting (at Geneva in October), more serious thought will have to be given to the question of how to support the lead price. The American idea of tariff protection or subsidy is, of course, only applicable to a closed-circuit market like the U.S.A. and is not applicable to the world scene. It may be noted, in passing, that after action in the recently-ended session of Congress had been despaired of, a U.S. Bill to provide subsidy payments to small U.S. lead and zinc mines just squeezed through. It provides for subsidies to mines producing less than 3,000 tons a year of lead and/or zinc on a declining scale over four years.

U.K. lead use in July was maintained at the satisfactory rate of 28,369 tons, while production of English refined was 6,590 tons and stocks edged up to 10,727 tons.

Zinc.—Apart from a purely technical "hump" in zinc prices[1] September has been featureless, with quotations disappointing from the producer viewpoint, but not an unfair reflection of the outlook. In the U.S.A. optimistic predictions

[1] See Table, p. 240.

[1] See Table, p. 240.

have been made about zinc consumption next year—provided the motor-car industry obliges with a production of 6,500,000 vehicles. In the U.K. the outlook is rather in the reverse direction at present, although in Europe as a whole it is not so bad.

U.K. July zinc consumption was 27,814 tons and, as before, the weak areas are the high grades, g.o.b. and Prime Western showing an improvement on the seven months over the same period of 1960. Production was 7,051 tons and stocks eased back to 65,328 tons.

Aluminium.—In Europe aluminium has continued a competitive market at both the ingot and semi-fabricated products stages, but the main area of interest in September has been North America, where the admittedly high U.S. domestic price was forced down two cents per lb. in the latter part of the month. The move was started by the Aluminum Co. of Canada agreeing to offer aluminium to U.S. consumers at the Canadian domestic price of 23·25 Canadian cents per lb. at the Canadian border. Allowing for the discount on the Canadian dollar this could be taken to the New York area, for instance, well under the U.S. domestic price of 26 cents, which shows how vulnerable the latter was. The U.S. producers may yet retaliate by trying to restore some of the cuts that have been made in the U.S. import duty in recent years (It is still not low at 1·25 cents per lb.), but for the moment they have cut ingot prices by 2 cents and the whole range of semis has been affected, although mostly not in proportion. In the U.K. the price remains £186 per ton (equivalent to 23·25 U.S. per lb.).

Iron and Steel.—The steel recession seems to be deepening and although September figures of output will probably show some improvement over the very low level of August, when poor demand and late holidays reduced production considerably, the steel industry is now expecting to wait until next spring for a general recovery. News from the various steelmaking regions continues to be largely taken up with fewer shifts, temporary and permanent closures of mills and works, shrinking order books, and keener competiton for available business.

The market situation should not be painted too black, of course. Steel consumption in many industries, especially constructional and some branches of heavy engineering, continues very good and the current recession in steel production is to a substantial degree due to the fact that consumers are now living to a large extent off their stocks. Although total steel production so far this year is lower than the corresponding period of 1960 alloy steels have done slightly better, but it remains to be seen how long this state of affairs will continue, for reports from Sheffield speak of declining orders and shortening deliveries.

On the export front shipments of iron and steel fell in August from July, but were comfortably higher than those in August last year. Exports of sheet steel have done very well, rising to the highest for many years and bringing the total for the first eight months of the year to nearly 250,000 tons, as compared with about 175,000 tons in the same period of 1960. Tinplate exports, on the other hand, have fallen considerably.

Iron Ore.—Owing to falling pig-iron production imports of iron ore into the U.K. have been restricted. Total arrivals in the first eight months of this year at 10,700,000 tons were 10% below the level of a year ago. Home ore production, on the other hand, has not been so severely affected and the total in the first seven months of 1961 (latest figures available) was at a higher rate as compared with 1960.

Antimony.—Over the past month the antimony metal and ore markets have been somewhat steadier following the drifting tendency shown in August. Prices have been maintained at the same level as for the past few months, for 60% ore at from 26s. to 28s. per unit c.i.f. Domestically produced 99% regulus is still quoted at £230 per ton and 99·6% at £237½ per ton.

Arsenic.—So far this year the general position of arsenic has remained fairly dull and nothing has changed in September. The price of metallic arsenic in the U.K. is still held at £400 per ton and of arsenic trioxide at £40 to £45 per ton.

Cobalt.—The prospect of world cobalt supplies remaining plentiful for some considerable time ahead is still apparent. Throughout September the cobalt market has remained featureless and contract supplies of metal continue to change hands within the U.K. at 10s. 9d. per lb. and to others the price remains at 12s.

Cadmium.—The cadmium market in the U.K. has remained in the position analysed earlier. in September. The current price of cadmium remains at 11s. per lb. Talk of a rise is not now heard—perhaps because hope is now deferred. At any rate the question is not very opportune, with consumption still in the doldrums.

Chromium.—The chromium market has remained largely unchanged throughout September and prices are still quoted in the range of 6s. 11d. to 7s. 4d. per lb.

Tantalum.—The tantalum market has continued strong throughout the past month and the current price per unit c.i.f. for a good

60% ore of 1,200s. to 1,300s. could easily advance.

Platinum.—Throughout September the platinum market has been somewhat steady, with the big producers continuing to meet the contractual demands of their customers. The U.K. prices remain the same at £30¼ per oz. for this material and at £27½ to £28 for "open-market" material.

Iridium.—This market has been extremely quiet throughout the past month. The prospect of a change in the state of the iridium market in the near future is still unclear. The U.K. price has been held steadily at £20 to £26¾ per troy oz.

Palladium.—The palladium market has been quite steady throughout September and the U.K. price has been maintained at £8½ to £9¾ per troy oz., depending upon whether the seller is offering Russian or Western metal.

Osmium.—The osmium market has been quite uninteresting throughout September. The price is still held at £17 to £25 per troy oz.

Tellurium.—Tellurium's future continues to look bright. There has been no change in the price of powder, which remains at 37s. 6d. per lb. Sticks are now quoted nominally. The market has remained healthy.

Tungsten.—The tungsten-ore market has moved from periods of quietude to periods of deadness and back again throughout the past month. The current range for tungsten is now 120s. to 123s. c.i.f. per long ton unit for Contract "B" material.

Nickel.—The nickel market has been quite routine throughout September and the price is still quoted at £660 per ton. However, it is a reflection of the generally easier supply position that, in the U.K., scrap prices have not regained their earlier relationship to new metal prices.

Chrome Ore.—The chrome-ore market has remained very quiet throughout the past month, but next month should see some activity on 1962 contracts. The price for Rhodesian metallurgical remains at £15¼ per ton c.i.f., the official Turkish export price for chrome ore remains at $30 per ton f.o.b.

Molybdenum.—The molybdenite market has continued strong in September although in one or two directions demand has not been so insistent. Russian material may now be becoming a competitive element. The price remains at 10s. per lb.

Manganese.—The price for manganese ore is still quoted in the range of 66d. to 69d. per long ton unit of Mn c.i.f. The market has been quiet throughout the month. The latest news from India is that manganese mine owners and exporters are seeking certain concessions from the Government in order to make Indian manganese more competitive on the international market—at the moment this material is some $4 per ton more than the international price.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum, 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98%, per ton

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Sept. 8	952 0	960 10	232 12½	235 17½	64 3¾	65 16½	73 16½	74 13¾
11	936 0	945 10	231 10	234 7½	63 17½	65 10	72 6¼	73 6¼
12	944 0	950 10	231 12½	234 12½	64 1¼	65 15	72 1¼	72 18¾
13	953 0	959 10	232 12½	235 15	64 1¼	65 16¼	72 6¼	73 2½
14	946 0	955 10	231 17½	235 2½	64 8¾	66 1¼	72 16¼	73 11¼
15	943 0	954 10	231 17½	234 17½	64 1¼	65 16¼	73 2½	73 18¾
18	944 0	954 10	230 2½	233 17½	64 2½	65 16½	73 8¾	74 2½
19	940 0	952 10	228 12½	232 2½	63 18¾	65 13¾	73 15	74 8¾
20	935 0	946 10	226 2½	230 7½	63 13¾	65 8¾	73 11¼	73 16¼
21	939 0	951 10	227 17½	231 17½	64 1¼	65 16¼	74 7½	74 13¾
22	942 0	956 10	226 2½	230 12½	64 2½	65 17½	75 5	75 8¾
25	958 0	968 10	225 17½	230 7½	64 1¼	65 16¼	75 12½	75 13¾
26	960 0	967 10	222 12½	227 2½	63 11½	65 6¼	74 8¾	74 8¾
27	952 0	961 10	222 17½	227 2½	63 13¾	65 6¼	73 17½	73 16¼
28	961 0	968 10	225 7½	229 2½	63 2½	64 18¾	73 13¾	73 18¾
29	958 0	965 10	223 5	227 5	62 16½	64 11¼	73 7½	73 16¼
Oct. 2	951 0	960 10	221 12½	225 2½	62 2½	64 5	71 8¾	72 8¾
3	944 0	954 10	222 12½	225 12½	62 7½	64 5	73 2½	73 8¾
4	942 0	954 10	226 17½	228 12½	63 7½	65 2½	73 11¼	73 13¾
5	943 0	953 10	229 2½	230 12½	63 5	64 17½	72 13¾	73 3¾
6	940 0	949 10	229 2½	230 7½	63 2½	64 12½	71 7½	72 3¾
9	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	August		September	
	Treated Tons	Yield Oz.†	Treated Tons	Yield Oz.*
Blyvooruitzicht	145,000	89,906	140,000	86,828
Brakpan	146,000	18,888	142,000	18,896
Buffelsfontein‡	155,000	68,022	156,000	68,584
City Deep	117,000	23,760	112,000	23,456
Cons. Main Reef	39,000	8,739	39,000	8,704
Crown Mines	184,000	32,242	178,000	31,382
Daggafontein	224,000	45,361	224,000	45,566
Dominion Reefs	41,300	35	40,600	—
Doornfontein‡	124,000	53,630	125,000	54,056
D'rb'n Roodeport Deep	202,000	37,869	196,000	31,382
East Champ D'Or‡	12,500	231	12,500	252
East Daggafontein	108,000	18,523	108,500	18,717
East Geduld	129,000	36,249	122,000	34,282
East Rand P.M.	254,000	58,137	235,000	57,025
Eastern Transvaal Consol	20,200	6,078	20,300	6,048
Ellaton‡	23,000	5,498	23,000	5,535
Freddies Consol	65,000	13,443	65,000	10,907
Free State Geduld	99,500	87,026	99,500	87,035
Free State Saaiplaas	62,000	16,988	66,000	18,086
Geduld	81,000	13,060	75,000	12,558
Government G.M. Areas‡	35,000	7,965	34,000	7,650
Grootvlei Proprietary	227,000	46,935	225,000	46,529
Harmony Gold Mining	202,000	37,869	194,000	78,286
Hartebeestfontein‡	136,000	62,560	136,000	62,356
Libanon	119,000	30,290	119,000	30,901
Loraine	85,000	27,625	85,000	28,900
Luipaards Vlei‡	110,000	14,299	110,000	14,218
Marievale Consolidated	102,000	24,225	99,000	23,520
Modderfontein East	63,000	6,470	62,000	6,464
New Kleinfontein	72,000	10,126	65,000	9,844
New Klerksdorp‡	—	—	—	—
President Brand	132,000	102,391	133,000	103,085
President Steyn	111,000	41,933	112,000	42,150
Rand Leases	192,000	26,112	180,000	25,020
Randfontein‡	110,000	9,525	105,000	8,711
Rietfontein Consolid't'd.	12,000	3,149	12,000	3,106
Robinson Deep	52,000	9,951	51,000	10,060
Rose Deep	27,000	4,245	25,000	4,209
St. Helena Gold Mines	190,000	66,507	185,000	64,758
Simmer and Jack	72,000	12,344	72,000	12,357
S. African Land and Ex.	110,000	22,185	113,000	22,792
S. Roodepoort M.R.	31,000	7,515	30,000	7,313
Spaarwater Gold	11,200	3,604	11,200	3,638
Springs	96,000	14,131	97,000	14,263
Stilfontein Gold Mining‡	185,000	83,065	185,000	83,100
Sub Nigel	66,500	15,142	66,500	15,162
Transvaal G.M. Estates	—	—	—	—
Vaal Reefs‡	116,000	54,230	118,500	55,695
Van Dyk Consolidated	77,000	11,214	75,000	10,907
Venterspost Gold	128,000	39,040	130,000	39,332
Village Main Reef	36,200	4,344	37,000	4,533
Virginia O.F.S.‡	140,000	26,896	143,000	28,572
Vlakfontein	53,000	19,640	53,000	19,626
Vogelstruisbult‡	80,000	17,312	80,000	17,284
Welkom Gold Mining	105,000	33,531	105,000	33,596
West Driefontein‡	182,000	142,783	182,000	142,860
West Rand Consol.‡	222,000	22,861	216,000	22,229
Western Holdings	175,000	122,063	175,000	122,503
Western Reefs	155,000	45,182	155,000	45,182
Winkelhaak	99,000	33,660	98,000	33,321
Witwatersrand Nigel	19,400	4,277	19,400	4,275

* 251s. 8d. † 250s. 3d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION *

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
June, 1960	17,968,300	73 9	46 3	27 6	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	18,103,100	74 0	46 4	27 8	32,201,685
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,272,800	76 2	47 0	29 2	33,039,583
Jan., 1961	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,858,100	—	—	—	31,924,315
April	—	—	—	—	—
May	—	—	—	—	—
June	18,419,350	—	—	—	65,772,460†

* 3 Months. † R.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
September, 1960	1,774,967	35,352	1,810,319
October	1,777,495	35,967	1,813,462
November	1,775,624	36,159	1,811,783
December	1,744,406	34,044	1,778,450
January, 1961	1,785,614	34,407	1,820,021
February	1,759,373	32,046	1,791,419
March	1,837,280	38,843	1,876,123
April	1,837,511	29,437	1,866,948
May	1,885,415	42,062	1,927,477
June	1,887,594	35,858	1,923,452
July	1,899,248	34,977	1,934,225
August	1,926,670	40,346	1,967,016

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
December 31, 1960	364,407	32,791	397,198
January 31, 1961	384,816	33,513	418,329
February 28	396,533	33,577	430,110
March 31	398,626	33,736	432,362
April 30	398,012	34,005	432,017
May 31	396,437	33,587	430,024
June 30	392,591	33,180	425,771
July 31	389,255	33,200	422,455
August 31	382,733	33,244	415,977

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Sept. 16		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	17,500	2,733	3,485
Electrolytic Zinc	17,628	779	4,979
Lake George	15,550	936	1,807
Mount Isa Mines**	50,922	2,860†	3,636
New Broken Hill	52,763	5,146	11,784
North Broken Hill	30,089	5,928	6,305
Zinc Corp.	53,307	6,622	10,560†
Rhodesia Broken Hill*	—	3,817†	7,414†

* 3 Months, ** Copper 3,670 tons blister; 4,906 tons concs.; † Metal.

RHODESIAN GOLD OUTPUTS

	Aug.		Sept.	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	21,700	4,253	—	—
Globe and Phœnix	4,940	2,653	—	—
Motapa Gold Mining	—	—	—	—
Mazoe	2,856	—	—	—
Coronation Syndicate	12,851	—	—	—
Phœnix Prince*	35,830	3,247	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	Aug.		Sept.	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	—	—	—	—
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	38,000	32,750	37,500	32,250
Bibiani	—	—	—	—
Bremang	—	—	—	—
Ghana Main Reef	—	—	—	—
Konongo	8,010	4,374	—	—
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1960		1961	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,902	29,711	47,673	22,101
February	45,754	29,865	44,164	13,250
March	45,309	29,656	52,507	7,256
April	48,607	6,847	50,090	7,992
May	47,542	62,912	—	—
June	45,884	34,298	—	—
July	44,865	33,323	—	—
August	48,284	28,931	—	—
September	48,865	38,951	—	—
October	47,473	37,308	—	—
November	46,439	33,896	—	—
December	48,778	26,327	—	—

WESTRALIAN GOLD PRODUCTION

	1959	1960	1961
	Oz.	Oz.	Oz.
January	63,924	64,794	62,434
February	65,035	66,789	73,271
March	65,408	61,941	69,360
April	62,686	65,373	62,569
May	64,184	66,682	66,352
June	74,590	74,902	81,562
July	78,974	67,623	61,886
August	68,546	67,466	71,894
September	66,501	68,794	—
October	70,427	67,310	—
November	68,858	107,815	—
December	117,474	76,269	—
Total	861,122	855,758	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Aug. 15		To Sept. 12	
	Tons	Oz.	Tons	Oz.
Central Norseman	13,489	7,438	14,100	7,496
Gold Mines of Kalgoorlie	40,783	12,374	39,353	11,366
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	33,323	4,475	33,695	4,657
Lake View and Star*	—	—	—	—
North Kalgurli	29,053	7,088	—	—
Sons of Gwalia	12,738	2,970	—	—
Mount Morgan	—	4,380	—	5,063

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
April, 1960	779,487	218,393	42,997	7,426,262
May	784,391	225,550	32,174	7,705,153
June	791,488	223,833	49,765	7,756,490
July	779,426	222,179	37,002	7,664,968
August	712,792	202,025	35,722	6,883,254
September	772,984	208,019	29,251	7,114,785
October	805,753	228,914	33,808	7,860,787
November	785,133	230,377	31,149	7,917,352
December	783,501	229,639	37,560	8,020,961
January, 1961	804,026	227,771	27,776	7,901,743
February	737,859	214,763	33,291	7,465,046
March	814,951	234,228	34,181	8,128,958
April	770,931	225,836	32,949	7,842,394
May	794,700	233,162	34,071	8,088,356
June	762,113	210,470	33,080	7,626,339
July	698,924	201,746	30,333	7,308,414

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Aug.		Sept.	
	Tons	Oz.	Tons	Oz.
Clutha River	—	493	—	528
Lampa (Peru)†	—	31,784	—	52,668
New Guinea Goldfields	4,393	1,501	—	—
Yukon Consol.	—	$390,000	—	—

† Oz. Silver : Copper, 101 tons ; 166 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (*a*)	Lead
1960	290,596	104,889	297,510
Provisional			
1961—January	15,070	8,169	15,540
February	26,716	8,265	26,437
March	27,535	9,680	26,146
April	23,759	9,548	21,279
May	29,032	9,017	28,155
June	—	—	—
July	—	—	—
August	—	—	—
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

(*a*) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	July	Aug.	Sept.
Ampat Tin	64	60	—
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Berjuntai	364	320	—
Chenderiang	20	19	—
Gopeng Consolidated	153	171	—
Hong Fatt (Sungei Besi)	—	—	—
Hongkong Tin	65	69	—
Idris Hydraulic	22	25	—
Ipoh	21½	14	9
Kampong Lanjut	146½	163	—
Kamunting	177	144	—
Kent (F.M.S.)	42	36	—
Kepong	—	—	—
Killinghall	25	11	—
Kinta Kellas	13	11	13½
Kramat	41	35½	—
Kuala Kampar	105½	125	—
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Larut	19	20	—
Lower Perak	133	93½	—
Malayan	213½	173	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	—	—
Pengkalen	38	58	—
Petaling Tin	103	110	—
Rahman Hydraulic	—	37	—
Rambutan	19	19	—
Rantau	79½	64	—
Renong	—	—	—
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	38	38	40
Southern Kinta	454	412	—
Southern Malayan	335	340	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	32	32½	—
Tanjong	75	66½	—
Tekka	—	—	—
Temoh	—	—	—
Tongkah Harbour	148	145	—
Tronoh	—	—	—

* 3 Months.

NIGERIAN MINE OUTPUTS (TONS)

	July	Sept.
Cassiterite	818	—
Columbite	208	—
Felspar	—	—
Gold*	62	—
Kaolin	—	—
Lead Ore	—	—
Limestone	61,266	—
Monazite	1	—
Oil	237,361	—
Tantalite	3	—
Thorite	—	—
Tin Metal	73	—
Wolfram	—	—
Zircon	71	—

* Oz.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	August		September	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	387	96	—	—
Anglo-Burma Tin*	—	—	—	—
Bangrin	17	—	19	—
Beralt	3	185†	3	182†
Bisichi	—	—	—	—
Ex-Lands Nigeria	47	—	62	—
Fabulosa	—	—	—	—
Geevor	41	—	58	—
Gold and Base Metal	60	6	—	—
Jantar Nigeria	16½	33½	—	—
Jos Tin	12	—	—	—
Kaduna Prospectors	7	—	—	—
Kaduna Syndicate	25	—	—	—
Katu Tin	14	—	9	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	10	—	—	—
Naraguta Tin	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	95	—	119	—
South Bukeru	—	—	—	—
South Crofty	40	—	—	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	1½	1½	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

July, 1961.

Gold	1,937,547 oz.
Silver	212,405 oz.
Diamonds	257,510 carats.*
Coal	3,758,094 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 4,552 tons of 98·83%.
Tin	234 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	16,271 tons.
Chrome Ore	91,212 tons.
Manganese Ore	119,890 tons.
Lead Concs.	10 tons.

* *May, 1961.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		July	Aug.
Iron Ore	tons	1,381,293	1,406,600
Manganese Ore	,,	20,819	40,203
Iron and Steel	,,	49,619	40,954
Iron Pyrites	,,	22,793	21,938
Copper Metal	,,	43,167	43,317
Tin Ore	,,	4,928	5,729
Tin Metal	,,	255	116
Lead	,,	16,479	17,240
Zinc Ore and Conc.	,,	29,864	21,366
Zinc	,,	9,847	13,992
Tungsten Ores	,,	363	707
Chrome Ore	,,	25,795	26,738
Bauxite	,,	100	30,755
Antimony Ore and Concs.	,,	27	1,264
Titanium Ore	,,	15,284	4,445
Zirconium Ores and Concs.	,,	3,963	1,057
Tantalite/Columbite	,,	130	47
Sulphur	,,	35,624	41,855
Barytes	,,	1,818	3,692
Asbestos	,,	15,018	13,636
Magnesite	,,	11,809	16,990
Mica	,,	420	529
Graphite	,,	709	564
Mineral Phosphates	,,	88,987	124,643
Molybdenum Ore	,,	129	1,130
Silicon	,,	644	481
Nickel	cwt.	15,387	94,747
Aluminium	,,	443,232	411,857
Mercury	lb.	171,342	24,362
Bismuth	,,	73,882	9,988
Cadmium	,,	243,263	204,309
Cobalt	,,	271,420	261,004
Selenium	,,	9,047	44,818
Petroleum, Crude	1,000 gal.	1,079,914	1,064,658

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	104	0	0
,, ,, 80% Technical	,,	94	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	5	0
Ammonia, Anhydrous	per lb.		1	6
Ammonium Carbonate	per ton	59	0	0
,, Chloride	,,	30	2	6
,, Nitrate	,,	36	5	0
Antimony Sulphide, golden	per lb.		4	4
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate 98–99%	,,	42	0	0
,, Chloride	,,	45	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	6
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	10	0
Boric Acid, Comml.	,,	77	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	17	0	0
Carbolic Acid, crystals	per lb.		1	2
Carbon Bisulphide	per ton	62	10	0
Chromic Acid	,,	245	0	0
Citric Acid	per cwt.	8	14	0
Copper Sulphate	per ton	79	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	3
Cresylic Acid, refined	,,		8	2
Hydrochloric Acid 28° Tw.	per carboy		13	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iodine	per kilo		17	4
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	,,	112	5	0
,, Nitrate	,,	114	0	0
,, Oxide, Litharge	,,	101	5	0
,, Red	,,	99	5	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	57	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	13	0	0
Magnesium Chloride	,,	20	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		5	10½
Nickel Sulphate	per ton	207	0	0
Nitric Acid, 70° Tw.	,,	35	0	0
Oxalic Acid	,,	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	per ton	131	16	8
,, Bromide	per lb.		2	6
,, Carbonate (hydrated)	per ton	72	10	0
,, Chloride	,,	21	0	0
,, Iodide	per kilo		19	3
,, Hydrate (Caustic) flake	per ton	92	0	0
,, Nitrate	per cwt.	3	10	0
,, Permanganate	,,	10	3	0
,, Sulphate, 50%	per ton	21	12	6
Sodium Acetate	,,	63	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	18	0	0
,, Bichromate	,,	109	13	4
,, Carbonate (Soda Ash) 58%	,,	16	0	6
,, Chlorate	per ton	90	0	0
,, Cyanide	per cwt.	6	18	10
,, Hydrate, 98/99%, solid	per ton	35	6	6
,, Hyposulphite, Comml.	,,	35	0	0
,, Nitrate, Comml.	,,	Nominal		
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	16	0	0
,, Sulphate (Glauber's Salt)	,,	12	5	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	40	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	13	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	8	10	0
Superphosphate of Lime, 18% P_2O_5	,,	13	10	0
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	121	10	0
,, Oxide	,,	95	10	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Sept. 6, 1961 £ s. d.	Oct. 6, 1961 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 1 9	2 3 1
Blyvooruitzicht (2s. 6d.)	1 5 0	1 3 6
Bracken (10s.)	1 0 3	19 0
Brakpan (3d.)	4 0	3 9
Buffelsfontein (10s.)	1 13 0	1 12 6
City Deep	13 0	11 6
Consolidated Main Reef	13 0	11 9
Crown Mines (10s.)	18 9	17 3
Daggafontein (5s.)	17 9	16 9
Dominion Reefs (5s.)	19 6	18 6
Doornfontein (10s.)	1 6 6	1 6 3
Durban Roodepoort Deep (10s.)	1 5 9	1 4 0
East Champ d'Or (2s. 6d.)	1 6	1 3
East Daggafontein (10s.)	9 0	8 6
East Geduld (4s.)	14 6	14 9
East Rand Ext. (5s.)	17 6	16 9
East Rand Proprietary (10s.)	1 4 3	1 4 3
Freddies Consol.	2 0	1 9
Free State Dev. (5s.)	3 3	3 3
Free State Geduld (5s.)	4 0 0	4 2 6
Free State Saaiplaas (10s.)	4 3	4 3
Geduld	2 2 6	2 2 6
Government Gold Mining Areas (3d.)	1 9	1 6
Grootvlei (5s.)	16 6	14 9
Harmony (5s.)	1 1 9	1 1 0
Hartebeestfontein (10s.)	2 1 3	1 19 9
Libanon (10s.)	13 3	11 9
Loraine (10s.)	16 9	18 0
Luipaards Vlei (2s.)	7 9	8 0
Marievale (10s.)	1 4 3	1 3 3
Modderfontein B (3d.)	1 3	1 3
Modderfontein East	7 6	7 6
New Kleinfontein	4 9	4 9
New Pioneer (5s.)	1 8 3	1 8 0
New State Areas (15s. 6d.)	6	6
President Brand (5s.)	2 13 3	2 8 9
President Steyn (5s.)	15 3	14 3
Rand Leases (9s. 3d.)	3 9	4 3
Randfontein	18 0	16 6
Rietfontein (3d.)	2 3	2 0
Robinson Deep (3d.)	3 9	3 9
Rose Deep (3d.)	5 6	5 6
St. Helena (10s.)	2 18 9	2 17 9
Simmer and Jack (1s. 6d.)	9	1 0
South African Land (3s. 6d.)	14 0	13 6
Springs (3d.)	1 0	1 3
Stilfontein (5s.)	1 6 6	1 6 3
Sub Nigel (3d.)	7 0	7 3
Vaal Reefs (5s.)	1 17 6	1 17 6
Van Dyk (3d.)	1 6	1 6
Venterspost (10s.)	18 6	18 6
Virginia (5s.)	2 6	2 3
Vlakfontein (10s.)	14 6	13 3
Vogelstruisbult (3d.)	3 3	4 3
Welkom (5s.)	12 6	12 9
West Driefontein (10s.)	3 17 6	3 16 3
West Rand Consolidated (10s.)	15 3	14 9
West Witwatersrand Areas (2s. 6d.)	2 10 0	2 10 0
Western Holdings (5s.)	5 17 0	5 13 9
Western Reefs (5s.)	1 3 6	1 2 9
Winkelhaak (10s.)	19 6	18 6
Witwatersrand Nigel (2s. 6d.)	6	6
Zandpan (10s.)	6 9	6 6
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	12 6	12 6
Coronation (2s. 6d.)	3 6	3 6
Falcon (5s.)	7 6	7 3
Globe and Phœnix (5s.)	1 9 6	1 8 9
Motapa (5s.)	—	—
GHANA:		
Amalgamated Banket (3s.)	—	—
Ariston Gold (3s. 6d.)	—	—
Ashanti Goldfields (4s.)	13 0	12 0
Bibiani (4s.)	—	—
Bremang Gold Dredging (5s.)	—	—
Ghana Main Reef (5s.)	—	—
Konongo (2s.)	9	9
Kwahu (2s.)	4 6	5 3
Offin River (2s. 6d.)	1 9	1 9
Western Selection (5s.)	3 9	3 6
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	2 0	1 9
Gold Mines of Kalgoorlie (10s.)	8 9	7 9
Great Boulder Propriet'y (2s.), W.A.	12 3	12 0
Lake View and Star (4s.), W.A.	1 3 6	1 2 9
Mount Morgan (10s.), Q.	11 6	11 6
New Guinea Gold (4s. 3d.)	1 3	1 3
North Kalgurli (1912) (2s.), W.A.	10 0	9 6
Sons of Gwalia (10s.), W.A.	2 6	2 6
Western Mining (5s.), W.A.	19 0	16 6

	Sept. 6, 1961 £ s. d.	Oct. 6, 1961 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	2 2 6	2 0 0
Kentan Gold Areas	16 3	14 9
St. John d'el Rey, Brazil	3 17 6	4 0 0
Yukon Consolidated ($1)	3 3	3 0
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	12 3	11 3
Esperanza (2s. 6d.), Cyprus	1 9	1 6
Indian (2s.)	5 6	5 3
MTD (Mangula) (5s.)	7 0	6 9
Messina (5s.), Transvaal	13 3	12 9
Mount Lyell (5s.), Tasmania	6 0	5 9
Nchanga Consolidated, N. Rhodesia	2 6 3	2 4 0
Rhokana Corporation, N. Rhodesia	2 6 0	2 5 9
Roan Antelope (5s.), N. Rhodesia	5 3	5 3
Tanganyika Concessions (10s.)	1 0 0	19 3
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	13 0	12 6
Burma Mines (3s. 6d.)	1 6	1 3
Consol. Zinc Corp. Ord.	3 8 6	3 2 6
Lake George (5s.), N.S.W.	3 0	3 3
Mount Isa, Queensland (5s. Aust.)	2 18 6	2 15 0
New Broken Hill (5s.), N.S.W.	2 10 3	2 5 6
North Broken Hill (10s.), N.S.W.	17 6	16 6
Rhodesia Broken Hill (5s.)	7 3	6 9
San Francisco (10s.), Mexico	18 3	18 6
TIN:		
Amalgamated Tin (5s.), Nigeria	12 3	11 3
Ampat (4s.), Malaya	16 3	15 9
Ayer Hitam (5s.), Malaya	2 9 0	2 2 6
Beralt (5s.), Portugal	1 8 0	1 5 6
Bisichi (2s. 6d.), Nigeria	5 0	4 9
Ex-Lands (2s.), Nigeria	4 0	3 9
Geevor (5s.), Cornwall	1 7 3	1 6 0
Gold Base Metals (2s. 6d.), Nigeria	2 0	1 9
Hongkong (5s.), Malaya	1 5 0	1 3 0
Jantar Nigeria (3s.)	5 6	5 3
Kaduna Syndicate (2s.), Nigeria	2 10	2 7½
Kamunting (5s.), Malaya	18 6	18 3
Malayan Tin Dredging (5s.)	1 14 0	1 12 0
Mawchi Mines (4s.), Burma	1 6	1 6
Naraguta Karama (5s.), Nigeria	1 0	1 0
Pahang (5s.), Malaya	17 6	16 9
Siamese Synd. (5s.)	19 6	18 3
South Crofty (5s.), Cornwall	6 6	6 6
Southern Kinta (2s.), Malaya	1 3 0	1 3 6
Southern Malayan (5s.)	1 12 6	1 11 0
Sungei Besi (4s.), Malaya	2 6 0	2 1 0
Sungei Kinta, Malaya	15 0	12 0
Sungei Way (2s. 4d.), Malaya	5 0	5 3
Temoh (7s. 6d.), Malaya	4 0	3 6
Tronoh (5s.), Malaya	3 7 6	3 4 0
United Tin Areas (2s. 6d.), Nigeria	1 9	1 9
DIAMONDS:		
Anglo American Investment	12 5 0	12 5 0
Consol African Selection Trust (5s.)	16 0	15 6
Consolidated of S.W.A. Pref. (10s.)	9 0	8 0
De Beers Deferred (5s.)	6 15 0	6 10 3
FINANCE, Etc.		
African & European (10s.)	2 10 0	2 10 0
Anglo. American Corporation (10s.)	6 8 3	6 0 6
Anglo Transvaal 'A' (5s.)	1 8 6	1 7 9
British South Africa (15s.)	2 19 6	2 19 3
British Tin Investment (5s.)	1 0 0	16 3
Broken Hill Proprietary	2 15 0	2 15 3
Camp Bird (10s.)	5 6	5 4½
Central Mining	1 4 6	1 13 6
Central Provinces Manganese (10s.)	16 9	16 0
Consolidated Gold Fields	2 10 9	2 10 6
Consolidated Mines Selection (10s.)	1 5 3	1 4 9
Corner House	10 6	10 3
East Rand Consolidated (5s.)	1 9	1 9
Free State Development (5s.)	3 3	3 3
General Exploration O.F.S. (2s. 6d.)	2 9	2 9
General Mining and Finance	4 2 6	4 1 3
Hendersons (4s.)	7 0	7 3
Johannesburg Consolidated	2 2 0	1 19 3
London & Rhod. M. & L. (5s.)	7 9	8 0
London Tin Corporation (4s.)	1 0 0	16 9
Lydenburg Est. (5s.)	10 0	11 3
Marsman Investments (10s.)	2 7½	2 7½
National Mining	2 0	2 0
Rand Mines (5s.)	2 18 9	2 15 0
Rand Selection (5s.)	1 18 9	1 17 6
Rhodesian Anglo American (10s.)	2 15 3	2 14 3
Rhodesian Corporation (5s.)	1 9	1 9
Rhodesian Selection Trust (5s.)	9 0	8 3
Rio Tinto (10s.)	1 14 3	1 16 0
Selection Trust (10s.)	4 18 0	4 9 3
South West Africa Co. (3s. 4d.)	8 3	8 6
Union Corporation (2s. 6d.)	2 9 0	2 5 6
Vereeniging	4 16 3	4 10 0
West Rand Inv. Trust (10s.)	2 3 9	2 2 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Shaft Equipment and Ventilation

A paper by C. F. B. van Wyk in the *South African Mechanical Engineer* for August provides "A Review of Progress in the Design of Shaft Equipment Aimed at a Reduction in Shaft Resistance." The author says that the problem of shaft resistance assumes major proportions in deep shafts which are almost without exception vertical shafts. Because of the high cost the shaft must permit of maximum hoisting capacity and maximum ventilation capacity. Maximum hoist utilization is normally obtained by installation of a large-capacity winder operating solely on rock-hoisting duty and a similar size winder operating solely on men and material duty. Frequently it is advantageous to install a smaller "service winder" which can cater for odd trips and do shaft maintenance duties.

The shaft has thus to accommodate, say, five or six conveyances, each running on two rails or guides and also the buntons and brackets on which to attach and support these guides. Room also has to be provided for pump columns, compressed-air columns, and water service pipes as well as power and signal cables. Rock sidewall support in the circular shaft is catered for by the tubular concrete shell so that the buntons may be designed for loads imposed by the guides and conveyances only.

In the case of circular shafts the buntons were spread to 10-ft. centres, later to 12 ft. 6 in. centres and are nowadays usually at 15-ft. centres. Larger centre distances of up to 20 ft. are now proposed. An empirical value of $\frac{W}{10}$ was normally assumed as the maximum horizontal force likely to be encountered at right angles to the bunton and maximum deflections of 1 in. were allowed under these conditions, where W is the total weight of a loaded conveyance.

Recent tests on a number of operating shafts show that generally these forces are only of the order of $\frac{W}{16}$ where the shaft guides are in good alignment, but at a number of points in all the shafts tested—where misalignment, bad joints, etc., were found—values as high as $\frac{W}{6}$ were common. It is evident that improved techniques of installation must be developed in order to reduce the degree of misalignment before more economical designs of shaft equipment can be contemplated. Reliable means of examining shafts and recording their condition must also be developed in order to maintain the steelwork in proper alignment.

Some inaccuracies in guide alignment will be unavoidable and it is necessary to consider their influence on the conveyance path. If buntons are out of true alignment a conveyance travelling downwards at speed will be deflected. This means that a more flexible bunton is an advantage from a hoisting point of view. Fortunately a slender bunton is of great advantaeg from a ventilation point of view as well.

The C.S.I.R. in South Africa, the author says, in conjunction with the Transvaal and Orange Free State Chamber of Mines, is actively engaged in determining the loading conditions in guide and bunton systems, which it is hoped will form the basis for the more economical designs of the future with the correct relation of stiffness in guides and buntons. The use of rope guides is also being investigated actively. So far, however, the clearances available between conveyances in multi-compartment shafts have not been sufficient to allow of their general acceptance in these fields where hoisting capacity in a shaft is of prime importance.

Reduction in the shaft resistance, it is suggested, can be achieved in three ways :—

(1) By improving the aerodynamic shape of obstructions.

(2) By reduction of the frontal area of obstructions.

(3) By increasing the spacing between obstructions.

The inter-relation of these methods is important and numerous tests have been carried out to establish the relative importance of each.

The most common type of bunton used in circular shafts in the past was the standard R.S.J. or I beam, usually 10 in. by 6 in. Experience and tests indicated that the shaft resistance obtained with these buntons even at 15-ft. spacing left a lot to be desired. Various schemes of improving conditions in existing shafts have been tried. Once the maximum improvement in resistance has been achieved by streamlining the shape of the bunton, further improvement can only be obtained by a combination of the other two methods—*i.e.*, (*a*) reducing frontal area and (*b*) increasing spacing between buntons. The author considers the former of these to be of greater importance. Should it be possible to reduce the width of the bunton to give a frontal area to shaft area ratio of 5%—which has in fact been achieved by using narrow hexagonal buntons *of equal strength*—the friction factor can almost be halved. Also, should it be possible to improve shaft alignment to the extent that the maximum forces to be designed for are reduced from $\frac{W}{6}$ to $\frac{W}{16}$, it will be evident that much larger economies in ventilation resistance are obtainable by using more slender buntons without any sacrifice in hoisting capacity and capital cost of the system.

Although shaft buntons have received a lot of attention the stage has now been reached where the auxiliaries—such as, pipes, cables, and brackets—should be subjected to the same close scrutiny because the relative influence of these auxiliaries although negligible with R.S.J. buntons assumes much larger proportions with well streamlined buntons.

The investigations carried out to date, it is pointed out, have been primarily concerned with buntons and it is felt that practical bunton shapes have reached a point of development sufficiently near the ultimate not to warrant very much further work in this direction. It is rather felt that the stage has been reached where attention should be paid to (*a*) reducing the number of buntons required per set by re-arranging the guides, (*b*) reducing the resistance of auxiliaries—such as, pipes, cables, etc.—possibly by placing them behind smooth shrouds, and (*c*) paying attention to the quality of concrete finishes obtainable in shafts, even to the economics of applying glossy finishes to such work.

Great advances have been made in reducing shaft resistance with comparatively minor increases in the economic velocity. From now on relatively greater economic gain can be expected from what might appear—at first sight—to be comparatively minor improvements in shaft resistance.

Transvaal Antimony

A note on the ore occurrences in the Phalaborwa carbonatite area, taken from the *South African Mining and Engineering Journal* for August 4, was published in the MAGAZINE for September. What follows is taken from the September 1 issue of the same periodical. In the first note reference was made to the ancient workings, particularly in the carbonatite zone, where copper and iron was recovered. To the east, along the Murchison Range, other old workings exist. Apparently copper was mined together with antimony and zinc, for reports exist of early Portuguese sailors acquiring trinkets containing copper alloyed with other metals. Gold was also probably recovered by these old workers.

The first recorded discovery by Europeans is that in 1870 by two prospectors, Sutton and Sutherland. Nothing was done about this until 1886 when the area was rushed by diggers of the Eastern Transvaal, largely as a result of their being forced out of other fields by the establishment of the concession system. By the following year the whole area had been pegged but the excitement was short-lived and a few years later the Government was unable to sell claims at any price. A number of small concerns lingered on and pressure by them and optimism about the area as a whole led to the building of the Selati railway line from Crocodile Bridge through the present Kruger National Park.

Gold production along the Murchison Range was sporadic. Most properties ran into metallurgical difficulties once the oxidized zones of ore were exhausted—a similar fate to that of the pioneer properties of the Barberton district.

Apart from gold many other minerals were mined on a small scale over the years, including copper, emeralds, corundum, cinnabar, and vermiculite. It was in 1928, however, that the possibilities of recovering antimony as a by-product of gold mining were seriously

considered. Pilot work was started at the Monarch mine towards producing antimony trioxide.

The Murchison Range consists of a belt of metamorphosed rocks of the Swaziland system striking east-north-east. On the west it is overlain by the Dominion Reef and Transvaal systems and on the other sides it is bounded by intrusive granites. The rocks dip either vertically or at a steep angle to the north and the generally accepted picture of the structure is one of steeply-folded synclines and anticlines. Of these the most significant is the Murchison syncline along the southern limb of which is the zone of antimony mineralization. In this is the " Antimony Line " which is about 400 yd. wide characterized by a number of orebodies carrying antimony minerals. Mineralization is general but it is only in certain localities that the concentration of antimony is such to justify exploitation under existing conditions. The payable deposits are on the southern side, the orebody consisting of a massive stibnite reef from 1 ft. to 10 ft. wide. In some areas a carbonate zone exists carrying sporadic values.

The first exports of antimony ore were made during World War I. Leaching and liquation extraction processes were tried out but were not successful and production ceased. The present plant was installed in 1936 to treat the arsenical and antimonial gold ores by flotation, the concentrates being roasted and then put through the cyanide process. After considerable experimental work tests on antimony flotation yielded encouraging results and a small plant was installed. This was increased in size. By this time gold ore reserves were declining and the antimony content of the Weigel orebody was increasing. The decision was taken to convert the existing plant to the production of antimony concentrates with gold as a by-product.

The main ore supply is now drawn from Consolidated Murchison's Gravelotte mine, in which there is a picking plant where waste is sorted out and high-grade ore picked. Lump ore for sale is produced by hand-cobbing. The remaining material on the belt together with grizzly fines is transported by road to the Weigel plant some 6½ miles away.

Milling is done by two ball-mills in closed circuit with hydrocyclones having a capacity of 550 tons to 600 tons a day. The mill product passes through a gravity concentrating section which recovers most of the gold and the arsenopyrite in the ore. The pulp passes to the flotation section which recovers a high-grade concentrate of over 60% antimony. This is thickened, sun-dried, and bagged for despatch.

The concentrate from the gravity section is dressed on James tables, middlings being reground to free the gold and then retabled. The concentrate is amalgamated with mercury and the bullion recovered from the amalgam. Where the arsenic concentrate is high the middlings are treated in the roaster and treated for gold.

The average monthly milling rate is 14,000 tons. Most of this has come from the Gravelotte mine over the past ten years, but of late tonnage has been augmented by ore from the United Jack and Mulati sections in order to conserve to some extent the Gravelotte ore reserve pending the completion of the exploration programme. Apart from this, work in other sections is confined to prospecting for possible extensions to the shoots that have been exploited and for new orebodies.

An exploratory programme is being actively pursued in trace analogous structures in an endeavour to find additional sources of ore either in new areas or contiguous to known deposits.

Modern prospecting methods are employed, including geochemical sampling for antimony and detailed structural geological mapping with the aid of aerial photography. Geochemical techniques are most valuable in areas where an overburden exists by concentrating attention on particular localities. In addition, detailed field mapping is being carried out in view of the apparent close relationship between certain structural features and antimony mineralization in an endeavour to explore areas.

In his 1960 review the chairman told shareholders that no new orebodies of any significance were discovered during the year but a number of possible areas had been indicated which would be tested by trenching, diamond drilling, and underground development.

Other small occurrences of antimony are known in the Murchison Range area and near Steynsdorp in the Barberton district but so far none of economic significance have been disclosed.

The Johannesburg Consolidated Investment Company, the technical advisors to Consolidated Murchison, were recently granted an Exclusive Prospecting Order by the Southern Rhodesian Government over a 24½ sq. mile area in the Lower Gwelo district " for all precious metals and antimony." Rhodesian reports suggest that the latter, free of penalty minerals such as copper and arsenic, may exist in workable quantities in the area. Antimony does occur throughout the Gatooma–Que Que schist belt but is usually contaminated.

Stoping at International Nickel

In the *Mining World* of San Francisco for September there is an account of undercut-and-fill stoping, a new mining method developed by the staff of the International Nickel Company of Canada, Ltd. This method is now used to mine 50% of the filled stopes at the company's Frood-Stobie mine near Sudbury. So successful is the new method, it is stated, that it will probably almost completely replace square-setting for pillar removal in the company's operations.

At Frood mine, where its development has taken place over the past several years, the new method has fully demonstrated its effectiveness in mining pillars and other difficult ground. Results have been so satisfactory that its use is being rapidly expanded in normal pillar recovery both at Frood and other Inco mines. Through the improvements it makes in safe working conditions and efficiency undercut-and-fill is also seen as the key to greater utilization of ore at depth in the company's mines and thus its influence will be felt for generations to come.

Undercut-and-fill is a method of extracting ore by mining successive layers, or cuts, working from the top down. After a cut of ore is completely mined out continuous laminated timber stringers are constructed along the sides the full length of the cut. Round logs are laid across the stringers to form a timber mat and the opening is then tightly filled with water-borne sand fill. Mining is then resumed on the next lower cut under the mat. As the cut advances the timber stringers are supported by round timber posts seated on the solid bottom of the cut. Mining, timbering, drilling, and blasting operations are repeated until all the ore in the cut has been removed. At this time another log mat is laid and the opening is filled.

The new method has shown a marked improvement over square-set efficiency. Undercut-and-fill has also proved effective in mining broken areas which would have been well-nigh impossible to mine by square-setting. At the same time it has eliminated the work of booming out ahead of square sets and building timber cribs for overhead cover.

A great deal of study and research was involved in the development of the method. One of the prime considerations, for example, was setting up a timbering system that would retain the fill mass and provide adequate support, involve only simple repetitive timbering methods, reduce timber consumption over square-set, and use low-cost round logs rather than the framed and dimensioned timber required for square-set. Finally the engineers hit upon the idea of fabricating strong continuous laminated plank stringers on the spot and laying the mat of logs on top of them. With this arrangement the only timbering required during the mining operation in the next cut below is the installation of posts under the stringers as the mining face advances.

Another key requirement to the success of the new method was that fill be placed tight to the bottom of the mat. Owing to the angle of repose of water-borne sand fill (tailing) it was realized that tight filling under a horizontal mat would not be possible. Observations were then carried out to determine the slope at which sand is deposited in free flow by introducing sand at one end of a working place and decanting drainage water at the opposite end. It was found that the average gradient was 4%.

An undercut-and-fill pillar was then mined with this slope to check this gradient. Observation towers were built up to the log mat, after which the cut, including the observation towers, was filled. Fill was introduced at the upper end of the slice with a decant point at the lower end. After the cut below was completed the sand was removed from the towers and an inspection made of the fill. It was found that the fill had packed tightly under the sloping mat and another problem had been overcome.

Design of a special toothed scraper for scraping on the rough, raw bottom of the cut from a muckpile steeply banked against the face was another important development. It was found that taking extra care in drilling lifter holes to line and grade avoided the necessity of reblasting and also assumed a relatively smooth bottom for scraping. Study of blasting technique for the new method showed that a round should be sequenced to blast upwards against the log mat, starting at the centre of the cut to avoid damaging the laminated stringers.

In a pillar stope the first cut is mined 10 ft. high and is timbered with standard 5·5-ft. square sets. Mining is started at the chute end and advanced across the ore in a series of 6-ft. rounds. This is an ideal length because it leaves only one unsupported joint in the stringer unsupported after each blast. The stringers are posted at the joint closest to the face so there is never more than 8 ft. of unsupported stringer. Just prior to filling the steel stringer plates are removed for re-use.

One advantage of this method is that the height of the cut and the width, too, can be

changed to fit different ground. Either of these can be changed while making a cut, of course. The higher the cut the larger the post normally required. This might be a limiting factor at some mines. At Frood it has been found that a safe working face 10 ft. high can be mined. Sand seals are installed at chute and manway before filling which requires about one shift with four men working.

The steel plates strengthen the joints and provide a cup to receive and hold the top ends of the posts when mining underneath the stringers. This simplifies timbering as no braces are needed between posts. A wooden saddle block is installed to extend above and between the two top bolts and between the plates at each joint before the timber mat is laid. This prevents the logs from transferring weight to plate and makes it easier to salvage plates for re-use.

Mineral Resources of New Brunswick

The background to the intense mining exploration and development going on in New Brunswick is reviewed in the *Precambrian* for August. It is noted that while there was much activity during 1960 it was in July of that year that a minor staking rush was precipitated in the Mt. Pleasant area of Charlotte County by Kennco Explorations (Canada), Ltd. Significant tin, tungsten, and molybdenum values were found in re-examined drill core by Mt. Pleasant Mines, Ltd., which held the ground in the area. Kennco acquired an option on the property and an extensive geological, geophysical, and drill programme commenced. The important values are found in a silicified and/or brecciated zone in a series of silicious volcanic flows and tuffs of Mississippian age. A recent geological map by the Mines Branch is available for the area and markedly assisted in the acquisition of ground.

In the north Noranada Mines, Ltd., conducted an exploration programme on a nickel prospect near the headwaters of the North-West Miramichi River. A drill programme outlined several sections of massive pyrrhotite carrying low copper and nickel values. Exploration is to continue next season.

New Jersey Zinc Exploration (Canada), Ltd., continued diamond drilling on their sulphide body at the Portage Lakes. In addition wide-scale geochemical and geological studies were made on the rest of the claim group.

Kennco Exploration (Canada), Ltd., carried out drill programmes on their massive sulphide deposit at Murray Brook and on a copper-rich skarn zone at Popelogan Lake.

Brunswick Mining and Smelting Corporation, Ltd., put down several drill holes on their Number 6 project to test possible extensions of a large massive sulphide body. On the Number 12 project four diamond-drill holes totalling 4,700 ft. were completed in co-operation with Sogemines, Ltd. These controlled holes tested the grade at 1,000 ft. Total ore reserves are now estimated to exceed 70,000,000 tons.

The orebodies of the district are massive sulphide replacements of two general types—an extremely fine-grained pyrite with sphalerite, galena, minor chalcopyrite, and appreciable values in silver and a pyrrhotite-chalcopyrite type with minor zinc, lead, and silver values and some gold values. Occasional assays for cobalt, cadmium, tin, nickel, and other metals have been reported. The two ore types are sometimes intimately mixed and may have to be mined together.

In this district metallurgy is a serious problem and it is well known that metallurgical difficulties have been retarding exploitation of the two large sulphide masses owned by the Brunswick Mining and Smelting Corporation. These difficulties are due not only to the very fine intergrowth of copper, lead, zinc, and iron minerals, which is sub-micron in size, but also to the presence of certain products of oxidation.

In addition to the ore types mentioned many of the numerous graphitic zones of the district carry appreciable amounts of primary marcasite and pyrite with very minor sphalerite, galena, and chalcopyrite. In a number of cases one or two drill holes have shown impressive widths of this material with ore grades, while subsequent drilling failed to find continuity of these values.

Weathering and oxidation have produced striking gossan zones over some of the sulphide bodies. Complete oxidation to depths of 150 ft. have been reported and depths of 30 ft. to 40 ft. are common. However, many of the massive sulphide zones have little or no gossan, while nearby masses are deeply oxidized. Secondary enrichment of the near-surface portion of the Heath Steele " B " ore-body has produced an upper layer with gold values approximating 0·2 oz. overlying a copper zone averaging 3%

to 4%. In some cases the presence of gossan or pieces of gossan float led to the discovery of the underlying sulphide mass.

After an orebody or sulphide mass has been found it is difficult at times to state just what method of exploration or combination of methods have been used to make the original discovery. In this area exploration techniques include airborne electro-magnetic and magnetic surveys, ground magnetic, electromagnetic, self-potential, and gravity surveys, detailed geological mapping, tracing of float rock, geochemical surveys, and water sampling, and pure geological deduction and extrapolation based on any and all combinations of these. Of the mines and prospects it is safe to say that ground electromagnetic work was the principal discovery tool in at least three cases and that airborne electromagnetic and magnetic survey results led to the discovery of at least five of the showings. Numbers 3 and 4 are reported to have been found by tracing mineralized float back to its source and pin-pointing the source with various ground geophysical surveys. Broad geological deduction followed by detailed geological mapping led to at least three discoveries.

In the recent past the most widely used exploration technique is to select an area which general geology indicates may be favourable and to fly it with electromagnetic equipment sometimes combined with magnetic gear. Areas of interesting anomalies are then staked or otherwise acquired and ground electromagnetic or self-potential surveys are used to pin-point the target area. Lines cut for these surveys are used for detailed geological mapping of outcrop, where present, and also of float material. Geochemical sampling at 100-ft. or even 50-ft. intervals may then be undertaken and a ground magnetometer survey added if it is thought that the body might contain pyrrhotite. In many cases gravity surveys have been used in an attempt to screen graphitic zones from possible sulphide bodies. Most or all of these methods are frequently used before diamond drilling is initiated.

At least two companies have used stream testing with both water and stream sediment sampling as a broad reconnaissance tool. Since so many of the streams and springs in New Brunswick give anomalously high results these methods have led to a large number of mineralized areas but to date cannot be credited with a discovery of importance. The same may be said of widespread reconnaissance soil sampling programmes which have been tried out in various parts of the Province.

Trade Paragraphs

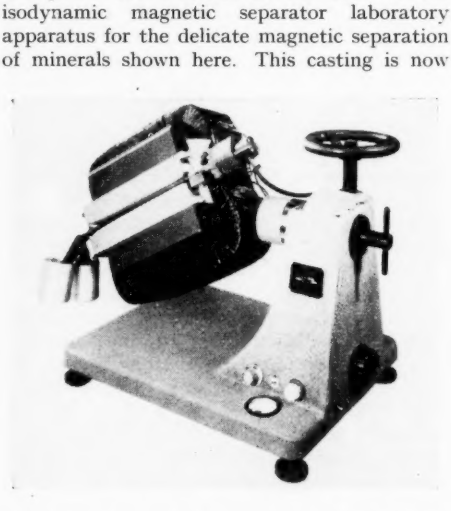
Metal Detection, Ltd., of Bickford Road, Witton, Birmingham, 6, announce that they recently moved to this address from Moseley Street. The telephone number is EAS 3215.

Soil Mechanics, Ltd., of 65 Old Church Street, London, S.W. 3, have formed an associate company—Soil Mechanics (Equipment), Ltd., for the supply of earth boring, rock drilling, and piezometer equipment as well as soil sampling apparatus and field testing appliances.

Sturtevant Engineering Co., Ltd., of Southern House, Cannon Street, London, E.C. 4, have recently published a revised edition of their booklet Paddle Bladed D Fans for use in dust and fume exhausting and a new booklet Sturtepak Anodes for cathodic protection of pipelines, etc.

Martindale Electric Co., Ltd., of Westmorland Road, London, N.W. 9, have introduced a new respirator weighing 4½ oz. which provides protection against dusts as fine as 0·5 micron. The face piece and filter box are made from lightweight plastic materials and shape of the filter box ensures unimpaired vision.

S. G. Frantz Co., Inc., of Brunswick Pike and Kline Ave., Trenton, New Jersey, have made a change in the material of the base of the isodynamic magnetic separator laboratory apparatus for the delicate magnetic separation of minerals shown here. This casting is now



aluminium instead of iron, reducing the weight of the base by 50 lb.

Wichita United, Ltd., of Basildon Industrial Estate, Basildon, Essex, announce that it has recently been registered in this country to undertake the manufacture and sale of the range of Wichita clutches and brakes for

Europe and the British Commonwealth, excluding Canada but including South Africa.

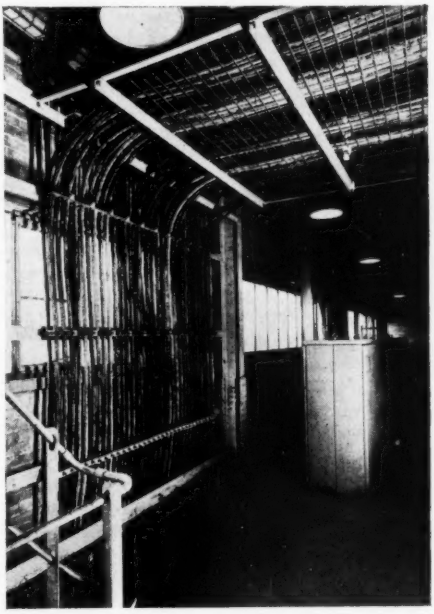
British Geon, Ltd., of Devonshire House, Piccadilly, London, W. 1, have lately made available, some particulars of a brattice cloth "hurdle" being constructed at Tymawr colliery. This cloth which is coated with green P.V.C. is now being increasingly used underground because of its superior abrasion and fire resistance.

Soil Mechanics, Ltd., of 65, Old Church Street, London, S.W. 3, have produced a further series of pamphlets in their geotechnical series. Chemical consolidation in civil engineering practice is covered in two of these, with examples of practice. Ground-water lowering is dealt with in another, while an associate company—Rock Mechanics, Ltd.,—is responsible for a separate leaflet concerned with engineering in rock.

Ferodo, Ltd., of Chapel-en-le-Frith, Stockport, in a recent announcement refer to the laying of the foundation stone by the chairman of Turner and Newall, Ltd., (Mr. Ronald Soothill), of a new factory they are building near Caernavon. Work on the erection is already far advanced, the site having been agreed in October last, and it is thought likely that the project will be completed by April next.

Dexion, Ltd., from their Overseas Division at Wembley, Middx., call attention to an example of a spare parts storage racking installed underground. This is at a maintenance depot at a mine in the Moselle region in France. As shown in the illustration this is built in Dexion slotted angle and chip-board, the materials for which can easily be taken underground and used by unskilled labour.

B.R.C. Engineering Co., Ltd., of Stafford, state that their Weldmesh has proved very successful as trays for carrying cablework at several N.C.B. Collieries, examples being at Mansfield, No. 3 Area, East Midlands Division and at Cwm, South Western Division. The photograph reproduced here by permission of the Board shows the main cable tray in the service basement of the electric winder house at Cwm Colliery.



Simon Engineering, Ltd., of Cheadle Heath, Stockport, announce that a contract for the design and supply of a coal preparation plant for Compania Carbonifera e Industrial de Lota in Chile, has been won by **Simon-Carves, Ltd.** The plant will be capable of handling 4,400 tons of coal each two-shift day and includes hand cleaning for the large coal, Baum washing of two different qualities of coals of intermediate size, together with water clarification and coal handling equipment. The washing capacity is 260 tons an hour of 4-in. and 2-in. coals. Of the different quality coals, one is for metallurgical and the other for industrial use.

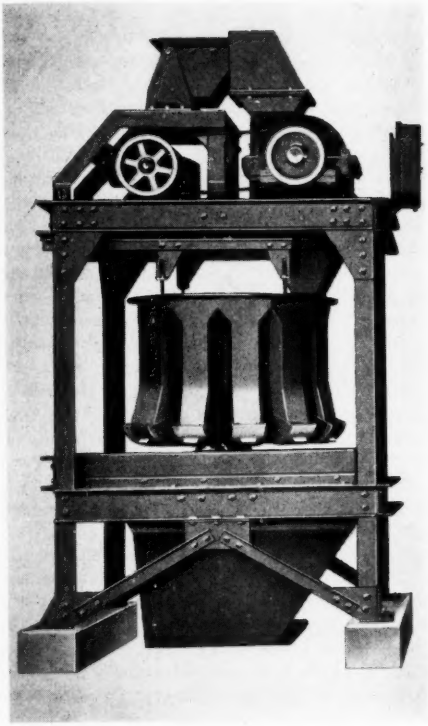
Stone-Plate Industries, Ltd., of Oceanic House, 1a, Cockspur Street, London, S.W. 1, have published a useful guide to the products

and services of the companies in the Group. Among these are Hayward Tyler and Co., Ltd., makers of submersible motors and pumps for mine unwatering and borehole work, Le Grand, Sutcliffe, and Gell, Ltd., who supply drilling rigs (including diamond drills) and undertake geological and geophysical exploration, Stone Chance and Co., Ltd., makers of Sumo electro-submersible pumps, for drainage purposes, and Stone-Wallwork, Ltd., makers of gears (including the P.I.V.) and vibratory feeders and conveyors for special purposes.

American Cyanamid Co., of 30, Rockefeller Plaza, New York, have recently produced an illustrated booklet under the title "This is Cyanamid", which outlines the scope of the company's business throughout the world in the field of pharmaceutical and general chemicals. Included among the latter are mining chemicals such as flotation reagents, which are widely known in mineral dressing circles, and A-M9 chemical grout for use in sealing off the flow of underground water in drill holes, mine shafts, tunnels, etc. In some accompanying notes the reader is reminded that the company in this country, Cyanamid of Great Britain, Ltd., of Bush House, Aldwych, London, W.C. 2, is a wholly-owned subsidiary which was founded in 1923 as Cyanamid Products, Ltd.

Paterson Engineering Co., Ltd., of 129, Kingsway, London, W.C. 2, refer in some notes to means of estimating the chloride contents of both the feed and boiler water. A quick method of arriving at such an estimate is provided by their chloride testing set. The feed water is tested by adding two drops of potassium chromate indicator to 70 mls. of feed water in the porcelain basin provided and then adding silver nitrate solution from a special burette until a permanent pink colour is obtained. The number of millilitres of silver nitrate used is equivalent to the concentration of chlorides as chlorine in grains per gallon and the conversion to sodium chloride is effected by multiplying this figure by 1·65. The procedure for testing the boiler water is then outlined.

Robert Dempster and Sons, Ltd., of Elland, Yorks, have compiled an illustrated leaflet which describes their range of rotary dividers or sampling machines, as they are better known in mineral processing. The largest of the series shown here complete with feeder and crusher will reduce 240 lb. of small material to 12 equal samples of 20 lb. each. The machine can be incorporated in any plant and arranged so that rejects are returned *via* a chute back into the main stream. The rotating barrel is driven



by a totally-enclosed geared motor positioned beneath. At the base the hub has a free-wheel device so that when not being driven the compartments can be rotated by hand.

Johnson, Matthey, and Co., Ltd., of 73–83, Hatton Garden, London, E.C. 1, have issued the first data sheets of a revised and enlarged series describing products for the electrodeposition of the noble metals silver, gold, palladium, rhodium, and platinum. Sheets issued deal with the types of high-purity silver anodes available for vat and barrel plating under a wide range of conditions. The Acid Hard Gold method of plating printed circuits, bright gold plating, and the Galvoric immersion process for decorative uses are covered and also palladium plating and the recently introduced DNS platinum process, which produces bright, heavy, and coherent deposits. Data sheets in preparation will give details of new rhodium plating methods and the well-established range of the company's gold and silver salts.

Ambuco, Ltd., of Standbrook House, 2–5, Old Bond Street, London, W. 1, which is a subsidiary company of Buell Engineering Co., Inc., of 123, William Street, New York, in an

illustrated booklet describe Ambuco cyclones for the scientifically efficient collection or recovery of industrial dusts. The principle of the cyclone is explained by diagrams, the double-eddy current being emphasized. Single or multiple units are offered. Hopper valves for control of the outflow of collected material are also referred to. In a separate note attention is called to a portable pilot plant constructed to demonstrate the results that can be obtained by the Venturi scrubbing process, whereby fumes are caused to pass through two complete cones of water to ensure up to 99·6% removal of entrained solids in the range 5 microns to 0·1 microns, for which there are several metallurgical applications.

Thomas Smith and Sons (Rodley), Ltd., of Rodley, Leeds, recently showed a film to representatives of the technical Press which is designed to demonstrate the application of their range of excavators and cranes to a variety of contracting, building, earth moving, and materials handling duties.

The company recently introduced a new auto-positive dual crowd system on their " 21 " excavators, which has the effect of providing additional " biting " power with marked simplification of the control. The hoist rope is spooled on the compensating drum to give automatic crowd action and the new system incorporates all the advantages of both the automatic rope crowd and the orthodox positive crowd systems. There is single-lever control of the shovel bucket with automatic crowding action and positive crowd action of the bucket arms in all positions.

Burt, Boulton, and Haywood, Ltd., Paint Division, of Belvedere, Kent, recently demonstrated to the Press a new product—Maximent—primarily intended as a flooring surface although having other applications. It is laid or rather spread like a thick paint after a primer has first been " painted " over the concrete surface of the existing flooring, whether indoor or outdoor. Something of the order of 32 sq. ft. of area can be covered by 1 gal. of the compound to give the required thickness of $\frac{1}{16}$ in. (About 1 pint of the primer will be required for the same surface area.) Apart from giving a bright appearance in a choice from several standard colours the surface has remarkable abrasive and chemical resistance properties which suggest its usefulness in works and offices, stores, and suchlike. It has also apparently been successfully applied to curtain walling. From a purely decorative point of view many variations in colour mixtures—to simulate marble, for example—are shown to be possible.

Hawker Siddeley Industries, Ltd., of Duke's Court, Duke Street, St. James's, London, S.W. 1, announce that Mirrlees, Bickerton, and Day, Ltd., have received an order for four diesel generating sets which will provide power for the gold fields of Kalgoorlie in West Australia. The order was placed on behalf of the principals, North Kalgurli (1912), Ltd. Each set consists of a 1,725 b.h.p. KSS 8-cylinder, HSBT turbocharged diesel with air charge cooling, direct coupled to a 1,220-kW Brush alternator. Delivery is scheduled for the three months December, 1961, to February, 1962. The engines are to operate on heavy fuel oil, which is approximately 30% cheaper than diesel fuel, resulting in a substantial decrease in power costs. The station will supply all the power needed to operate the mine winding gear and other equipment, making the mine entirely independent of outside supply. This is the second gold mine installation by the company in the area, the first being at the nearby Great Boulder Mine.

Fisher and Ludlow, Ltd., Material Handling Division of P.O. Box No. 12, Tipton, Staffs., draw attention to the fact that flexiroll troughing idler conveyors have been installed in the course of the modernization scheme at present being carried out by No. 1 Area of the National Coal Board's South-Western Division at Brynlliw Colliery in South Wales. Conveyors with 30-in. wide belts have been installed in the No. 1 and No. 2 " panels " of the south-east section of the Six Feet seam, their loads being discharged on to a third Flexiroll conveyor with a 36-in. wide belt running at right angles down the main gate road to a station on the main east intake, where the coal is loaded on to the underground loco. system. Flexiroll, primarily designed as a fireproof conveyor with no metal to metal contact, so that friction likely to cause over-heating is reduced to a minimum, uses Flexitex moulded plastic rollers mounted on semi-elliptical spring steel spindles, providing a shallow trough for light loads and becoming deeper as the lead increases. Nylon bearings are used throughout

Compagnie Generale de Geophysique, of 50, Rue Fabest, Paris, 7e, and **Marine Geophysical International, Inc.,** of Houston, Texas, have completed arrangements whereby the services of the Sparker may be available to the engineering clients of C.G.G. in Common Market, Mediterranean Basin, and French-speaking African countries. The Sparker is expected to take the place of fluvial or marine conventional seismic survey in all subsurface work. It gives a continuous seismic profile of

the bottom of the sea and the upper score feet of sediments at low cost. Developed in the United States, the Sparker source is obtained by regular underwater discharge of a high-voltage spark. The sound spectrum of the spark is very similar to that of a small detonator. The spark spectrum can be varied to low for petroleum and mineral exploration purposes and high for detailed engineering requirements. It has frequently been used in conjunction with drilling programmes. Once the various strata are identified on the records they can be carried forward by correlation and a maximum of information at a minimum cost obtained to guide the drilling.

Simon-Carves, Ltd., of Cheadle Heath, Stockport, have received a contract to design and erect a dense-medium coal-preparation plant at Bentley Colliery in the North-Eastern Division of the N.C.B. The plant will provide additional large coal cleaning facilities and be capable of washing 250 tons per hour, the remainder going either to the existing preparation plant or outloaded as a dry product. Primary and secondary Drewboy dense-medium separators, working in series, will comprise the new plant, together with all ancillary equipment.

Another notice from the company refers to electro-precipitation plants for the iron and steel industry, two more of which have been ordered. The first is for dealing with fume from two 360-ton open-hearth furnaces at the South Works of the South Durham Steel and Iron Co., Ltd., with a total gas volume of about 100,000 c.f.m. at 300° C. The high-efficiency precipitators will clean the gases to 0·04 grain N.c.f. The second order is for five electro-precipitators to remove dust from the discharge end of a sinter strand at Appleby Frodingham's Scunthorpe works. The guaranteed efficiency is 99·3% and the total gas volume will be about 335,000 c.f.m. at 212° F. Simon-Carves' precipitator interests were merged with those of **Lodge-Cottrell, Ltd.,** Birmingham, nearly a year ago at a time when both concerns were leading suppliers of precipitators to the iron and steel industry. Indeed, in less than four years, they have built a combined total of 22 open-hearth furnace fume precipitators and 29 sinter-dust precipitators.

Correction.—In the September issue, in a note put out by Neldco Processes, Ltd., the name of the Swedish company who are makers of the Sala safety blocks should have been given as Sala Maskinfabriks AB.

RECENT PATENTS PUBLISHED

☛A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

3,469 of 1958 (879,181). PERMUTIT CO., LTD. Removal of dissolved solids from liquids.

12,363 of 1958 (880,017). W. M. WEIL. Recovery of manganese from metallurgical slags, dusts, and ores.

17,844 of 1958 (877,932). W. PETERSON and S. WAWTROSCHEK. Method of producing mixture briquettes.

19,417 of 1958 (879,664). O. E. A. ASPEGREN. Reduction of metallic oxides.

26,930 of 1958 (878,610). MCDOWELL CO., INC. Wind-box seal for sintering machines.

39,772 of 1958 (879,839). E. A. POKORNY. Fusion electrolysis of niobium and in the resistance to oxidation of the metal.

12,392 of 1959 (879,382). SHERRITT GORDON MINES, LTD. Metal recovery process.

15,372 of 1959 (878,390). NATIONAL SMELTING CO., LTD. Production of beryllium.

35,132 of 1959 (880,130). DIAMOND ALKALI CO. Chromium production.

NEW BOOKS, PAMPHLETS, ETC.

☛Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

Handbook on Quarrying. Cloth, pocket size, 185 pages, illustrated. Price 7s. 6d. Aust. Adelaide : Department of Mines, South Australia.

Economic Geology of the Coalfields : Area II, Cowdenbeath and Central Fife. Second edition, by E. H. FRANCIS. Memoir of the Geological Survey of Scotland. Cloth boards, 152 pages, illustrated. Price 25s. London : H.M. Stationery Office.

Relation of Uranium Deposits to Tectonic Pattern of the Central Cordilleran Foreland. U.S. Geological Survey Bull. 1087—I. By F. W. OSTERWALD and B. G. DEAN. Paper covers, pp. 337–390, with maps. Washington 25, D.C. : Superintendent of Documents.

Stratigraphy of the Murray Basin in South Australia. S. Aust. Dept. Mines Bulletin No. 36. By N. H. LUDBROOK. Paper boards, 96 pages, illustrated, and 8 plates. Adelaide : Department of Mines, South Australia.

Kenya : Mines and Geological Department Annual Report, 1960. Paper covers, 23 pages. Price 3s. Nairobi : Government Printer.

Kenya : Geology of the Mandera–Damassa Area ; Geological Survey Report No. 48. By P. JOUBERT. Paper covers, 65 pages, illustrated, with maps. Price Sh. 22/50. Nairobi : Government Printer.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

Beryllium, Future : *Production, Utilization.* Beryllium : Update 1961. A. KNOERR, M. EIGO, *Engg. Min. J.*, Sept., 1961.

Iron-Ore, Future : *Progress, Review.* Iron Ore : The Big Picture. E. H. ROSE, *Min. Engg.*, Sept., 1961.

***Iron, Sweden :** *Activities, Grängesberg.* Progress at Grängesberg. J. GRINDROD, THE MINING MAGAZINE, Oct., 1961.

Lead, Future : *Price, Review.* The Price of Lead, 1961–1975. W. P. SHEA, *Engg. Min. J.*, Sept., 1961.

Production, Africa : *Operations, Rhodesia.* Mining and Metallurgical Operations at Rhodesia Broken Hill—Past, Present, Future. K. C. G. HEATH, *Bull. Instn. Min. Metall.*, Sept., 1961.

Production, Mineral : *Progress, Southern Africa.* Minerals and Metals for Sale. D. G. MAXWELL, *J. S. Afr. Inst. Min. Metall.*, Aug., 1961.

Production, Mineral : *Trends, World.* Trends in World Minerals Production, 1954–59. A. ROBERTS, *Mine, Quarry Engg.*, Oct., 1961.

†Resources, Africa : *Antimony, Transvaal.* Antimony from the Lowveld. *S. Afr. Min. Engg. J.*, Sept. 7, 1961.

†Resources, Canada : *Mineral, New Brunswick.* Exploration and Development in New Brunswick. *Precambrian*, Aug., 1961.

Resources, Sarawak : *Deposits, Bauxite.* Bauxite in Sarawak. E. B. WOLFENDEN. *Econ. Geol.*, Aug., 1961.

***Resources, Sweden :** *Uranium, Kolm.* The Kolm Deposits of Sweden. C. F. DAVIDSON, THE MINING MAGAZINE, Oct., 1961.

Geology

Copper Basin, Arizona : *Breccia, Mineralized.* Geology and Origin of Mineralized Breccia Pipes in Copper Basin, Arizona. W. P. JOHNSTON, J. D. LOWELL, *Econ. Geol.*, Aug., 1961.

Economic, Australia : *Pyrite, Queensland.* Bedded Pyrite and Micro-Organisms from the Mount Isa Shale. L. G. LOVE, D. O. ZIMMERMANN, *Econ. Geol.*, Aug., 1961.

Gold, Australia : *Occurrence, Bendigo.* Reflections on Gold Occurrences in Bendigo. F. L. STILLWELL, *Proc. Aust. Inst. Min. Metall.*, June, 1961.

***Kolm, Sweden :** *Occurrence, Origin.* The Kolm Deposits of Sweden. C. F. DAVIDSON, THE MINING MAGAZINE, Oct., 1961.

Mineral, Tin : *Tysonite, South Africa.* Tysonite from Mutue Fides. J. G. D. STEYN, *S. Afr. Geol. Survey Bull.* 35.

Pegmatites, United States : *Methods, Exploration.* Exploration of the Kings Mountain Pegmatites. T. L. KESLER, *Min. Engg.*, Sept., 1961.

Survey, Geochemical : *Copper, Africa.* Geochemical Prospecting Investigations in the Northern Rhodesian Copperbelt. J. S. TOOMS, J. S. WEBB, *Econ. Geol.*, Aug., 1961.

Survey, Geochemical : *Methods, Analytical.* A Comparison of Analytical Methods Used in Geochemical Prospecting for Copper. L. C. HUFF and others, *Econ. Geol.*, Aug., 1961.

Metallurgy

Concentrates, Cleaning : *Molybdenite, Canada.* Production of Pure Molybdenum Sulphide. E. BORBASH, *Canad. Min. J.*, Aug., 1961.

Exchange, Ion : *Processes, Review.* Ion Exchange Processes in the Atomic Industry. T. V. ARDEN, *Proc. Aust. Inst. Min. Metall.*, June, 1961.

Extraction, Solvent : *Uranium, Australia.* The Application of Solvent Extraction to the Recovery of Uranium in El Sherana Ore. J. T. WOODCOCK, *Proc. Aust. Inst. Min. Metall.*, June, 1961.

Iron, Recovery : *Process, Canada.* The Falconbridge Iron Ore Process. P. G. THORNHILL, *Canad. Min. Metall. Bull.*, Aug., 1961.

Roasting, Fluid-Bed : *Gold, Ontario.* Fluid-Bed Roasting Practice in the Red Lake Camp. K. P. WRIGHT, *Canad. Min. Metall. Bull.*, Aug., 1961.

Roasting, General : *Sulphides, Canada.* Roasting Practices at International Nickel. R. R. SADDINGTON and others, *Canad. Min. Metall. Bull.*, Aug., 1961.

Roasting, Magnetic : *Concentrates, Pelletized.* Experimental and Commercial Magnetic Roasting. R. L. CAVANAGH, A. J. LAST, *Canad. Min. Metall. Bull.*, Aug., 1961.

Roasting, Ore : *Processes, Review.* Roasting Rates and Elementary Mechanisms. E. PETERS, *Canad. Min. Metall. Bull.*, Aug., 1961.

Roasting, Suspension : *Practice, Canada.* Suspension Roasting of Zinc Concentrate at Trail. R. E. EYRE, *Canad. Min. Metall. Bull.*, Aug., 1961.

Sulphides, Roasting : *Practice, Canada.* Multiple-Hearth Roasting of Sulphides in the Zinc Roasting Plant at Flin Flon. B. SCHNEIDER, *Canad. Min. Metall. Bull.*, Aug., 1961.

Machines, Materials

Drills, Percussive : *Pressures, Air.* Higher Air Pressures for Down-the-Hole Percussive Drills. E. P. PFLEIDER, W. D. LACABANNE, *Mine, Quarry Engg.*, Oct., 1961.

Pump, Sump : *Drainage, Canada.* Milliken Continuous Settling and Sludging Pump. M. D. LAWTON, *Canad. Min. J.*, Aug., 1961.

***Swivel, Rope :** *Winding, India.* Controlled Swivel for Wire Ropes. A. SEETHARAM, THE MINING MAGAZINE, Sept., Oct., 1961.

Mining

Calculations, Computer : *Method, Mining.* Computer Calculates Best Method to Develop High-Angle Escalanite Vein. R. F. HEWLETT, J. N. FAICK, *Min. World* (San Francisco), Sept., 1961.

Handling, Hoisting : *Calculations, Winder.* A Convenient Mine Hoist Analysis. A. W. BRUNE, *Min. Engg.*, Sept., 1961.

Handling, Transport : *Trucks, Diesel.* Diesel-Engined Dump Trucks for Underground Transportation of Coal. E. P. EDWARDS, A. W. L. BRERETON, *J. S. Afr. Inst. Min. Metall.*, Sept., 1961.

***Hoisting, India :** *Control, Rope.* Controlled Swivel for Wire Ropes. A. SEETHARAM. THE MINING MAGAZINE, Sept., Oct., 1961.

Hygiene, Silicosis : *Suppression, Dust.* Dust Suppression on Anderton Shearer Loaders. *Inform. Bull. N.C.B.* 61/229.

†**Hygiene, Ventilation :** *Equipment, Shaft.* Progress in the Design of Shaft Equipment Aimed at a Reduction in "Shaft Resistance." C. F. B. VAN WYK, *S. Afr. Mech. Eng.*, Aug., 1961.

Research, Great Britain : *Coal, Nationalized.* Achievements of Scientific Research in the National Coal Board. W. IDRIS JONES, *Min. Engr.*, Sept., 1961.

Safety, Underground : *Prevention, Accident.* Featuring Mine Accident Prevention. *Canad. Min. J.*, Sept., 1961.

***Sinking, Rapid :** *Coal, United Kingdom.* Rapid Sinking at a British Colliery. THE MINING MAGAZINE, Oct., 1961.

†**Stoping, Canada :** *Undercut-and-Fill, Inco.* Undercut-and-Fill Stoping at the Frood-Scobie Mine. *Min. World* (San Francisco), Sept., 1961.

Support, Ground : *Use, Grouting.* San Manuel Lowers Costs by Grouting Bad Ground. *Min. World* (San Francisco), Sept., 1961.

Ore-Dressing

General, Germany : *Sulphides, Rammelsberg.* Processing the Rammelsberg Ores. *Mine, Quarry Engg.*, Oct., 1961.

Gravity, Cyclones : *Circuit, Spare.* Portable Spare Cyclone Assembly. *Engg. Min. J.*, Sept., 1961.

Flotation, Application : *Uses, Unusual,* Unusual Applications of the Flotation Process. L. A. ROE, *Deco Trefoil*, Aug.-Sept.-Oct., 1961.

Flotation, Coal : *Practice, Germany.* Present State of Coal Flotation in West Germany. K. SALLMANN, *Min. Engg.*, Sept., 1961.

Suspensions, Mineral : *Composition, Calculation.* The Composition of Suspensions. C. C. DELL, *Coll. Engg.*, Sept., 1961.

Transport, Hydraulic : *Slurries, Pumping.* Pumping Slurry. Ore-Dressing Notes, THE MINING MAGAZINE, Oct., 1961.